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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

SEPTEMBER, 1923

DOUBLE CONE FLOWERS
David Griffiths

BRANCHED EARS IN MAIZE
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A TWO-HEADED LAMB
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Date of Issue of This Number, October 5, 1923.

A BRANCHED EAR OF MAIZE—AN INHERITED ABNORMALITY

Many of the abnormalities thus far reported in Indian corn are inherited in a simple Mendelian manner, but this is partly because the cases of simpler inheritance have been studied first, and the more complicated problems deferred. The inheritance of this form of branched ears is not according to the usual Mendelian system. Mendelian ratios were not obtained and it was not possible to isolate a uniform branch-eared strain, or even to approach that condition. Continued self-pollination does not appear to increase the number of such plants, which are produced at a rate of about five normal plants to one bearing branched ears. The ear from which this strain originated came from a variety of maize grown by the Pawnee Indians. (Frontispiece.)

HERITABLE CHARACTERS OF MAIZE

XIV—Branched Ears

J. H. KEMPTON

Bureau Plant Industry

THE number of simple Mendelian characters reported for maize is increasing constantly and creating the erroneous impression that all heritable teratological variations result from changes in single hereditary units. Following the discovery of a new abnormality the customary procedure is to inbreed for several generations, propagating only those individuals which express the character in its most extreme form. After this treatment abnormalities which fail to behave as simple or comparatively simple characters when crossed with closely related normal individuals must bide their time until the mode of inheritance of the more simple characters has been determined satisfactorily. This procedure is quite logical and fully justified by the results, although it can but lead the reader unversed in genetic practice to believe that the inheritance of the majority of the most striking characters is quite simple.

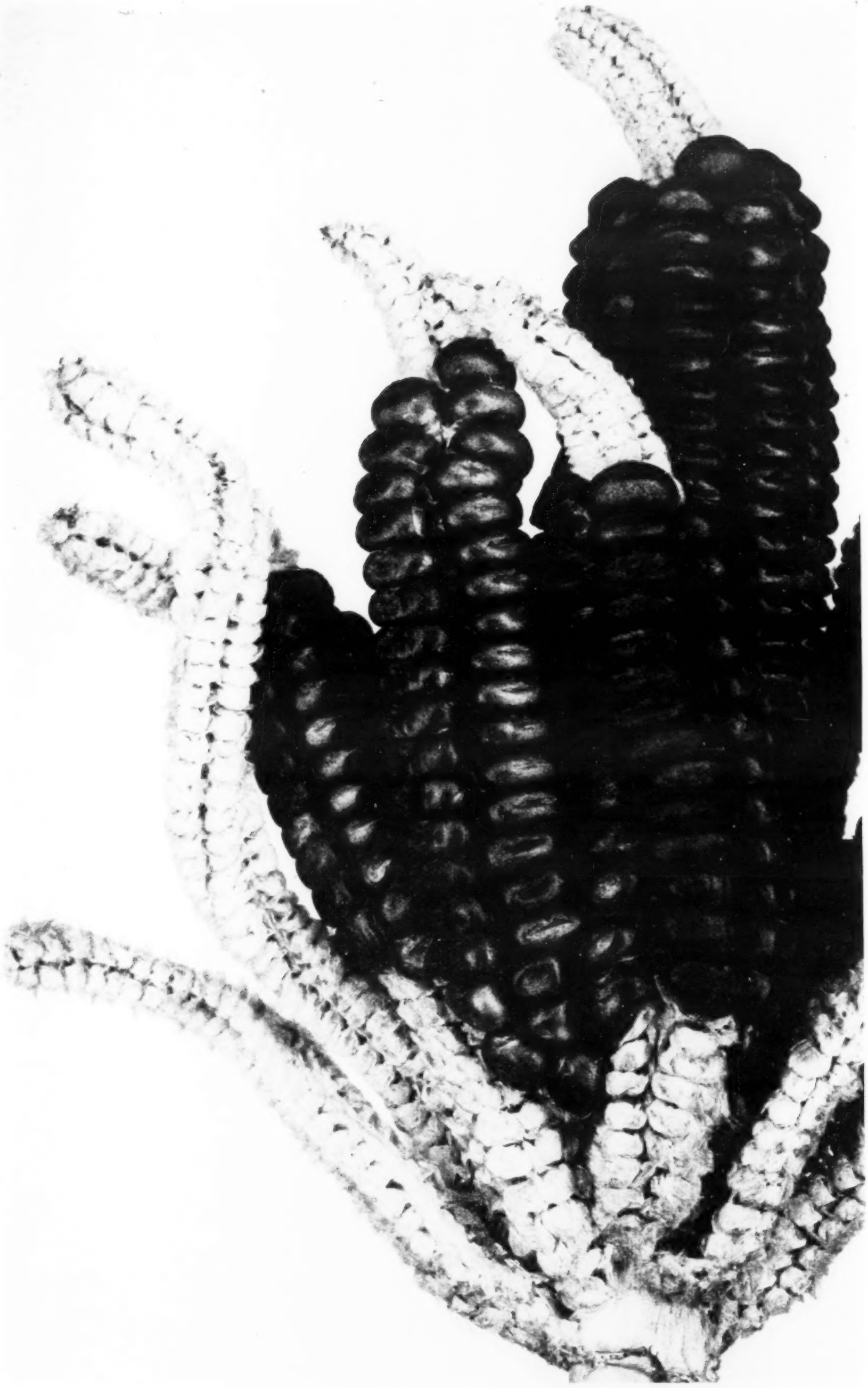
The present paper deals with a character fully as striking as most of its predecessors in this series but differing from them in the mode of inheritance. This character is manifested by the production of seed-bearing branches at the base of the ear and clearly represents a reversion to a less specialized form. It is well known that the terminal panicles of tillers or suckers commonly bear pistillate as well as staminate spikelets and that all degrees of the production of seeds in these inflorescences exist, ranging from normal branched staminate panicles to inflorescences completely resembling ears, having no branches and producing nothing but pistillate spikelets on fully developed cobs. So varied are the inflorescences of suckers that in order to classify the different sorts we have established sixty types which represent fairly well the stages from the normal branched staminate inflorescences to unbranched ears. The suckers borne on different plants range in type from something resembling an upper floral branch or ear to a replica of the main stalk. The variations in the type of inflorescence clearly result from the attempt to adjust a bisexual inflorescence on a monoecious plant which normally has the sexes in separate inflorescences.

In view of the unstable condition prevailing in the character of the inflorescences of suckers it seems noteworthy that the character of the ear should remain so constant though separated from the suckers by but a few metamers and related to them through an unbroken series of buds. In all maize plants there is a section of several metamers with dormant buds which separates the pistillate branches or ears from the vegetative branches or suckers and presumably it is in this transitional section that the character of the inflorescence becomes stabilized in an unbranched pistillate form.

Types of Branched Ears

Five forms of branched ears are recognized, of which bearsfoot and ramose are the most common, these having formed the basis of theories of the origin of the ear. They are shown in Figures 1, 2 and 3.

A third form in which two or more entire and otherwise normal ears are united in a single inflorescence was found by Collins and Doyle at Tuxtla,



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Mexico, where it is known by the name *Quachi,* a native word meaning twins[1] (Figure 4). This style of branching also is inherited but owing to the extremely long season required for the growth of the variety producing it no accurate analysis has been possible. Seeds from the original open-pollinated ears were planted in southern Florida and while the growth was unsatisfactory the nubbins produced ranged from normal unbranched cobs to those with as many as four branches of equal size. Recognized Mendelian ratios were not obtained and in any event, owing to the open-pollination of the parental ears the ratios could have little genetic significance.

A fourth form of branching which is of rather common occurrence especially in varieties of sweet corn, is a branch, or more rarely two or more branches, at the base of the ear inside the innermost husk (Figure 3). This branch is itself enclosed in several husks and has the form of a normal ear, usually with more than four rows and very rarely with well-developed seeds. The inheritance of this type of branching, though as yet not tested in great detail, seems very similar to that of the fifth form to be discussed.

The fifth form of branching consists of from one to many four-rowed branches at the base of the ear, usually with fully-developed seeds. These branches are naked but are enclosed in the husks which envelop the ear (Frontispiece). It is with this type of branched ear that the present paper deals, and for which the designation "branched ear" is proposed.

Origin of "Branched Ears"

In growing a large block of inbred varieties we have had the good fortune to self-pollinate an ear showing this latter type of branching. The original ear from which this variation descended was received from Melvin R. Gilmore, Curator of the Museum of the Nebraska State Historical Society. This ear was of a Pawnee Indian variety and like so many Indian varieties had eight rows of seeds while the plants grown from it produced many suckers or tillers. Seeds from the original normal ear were planted and produced thirty-eight normal plants. Of these, five were hand-pollinated. A self-pollinated ear from one of these five was planted the following season and eighty-eight plants were raised. Three of these plants produced branched ears of varying degree. The most extremely branched ear had eleven branches, all four-rowed, in addition to the central eight-rowed spike. This ear is shown in the Frontispiece, and its pedigree is given in Figure 5. Only the upper ear of the plant was branched but two ears borne on tillers were bifurcated at the tip.

As the pedigree shows, there have been four generations of self-pollinated, branched ears and as yet no progenies breeding true for branched ears have been obtained. This behavior is in marked contrast with that of the ramose type of branched ear or even that of the bearsfoot or fasciated form.

The amount of branching varies, though never approaching the ramose form but not infrequently the upper ear will bear one or more branches and the lower none. The tendency for the upper ear to be more branched than the lower one is a curious phenomenon in view of the nature of the abnormality. Thus the lower ears would be expected to approach suckers more nearly than would the upper ears and if there are to be differences between them in the amount of branching the lower ears should have more rather than fewer branches than upper ears. This tendency for lower ears to have fewer branches than upper ears has been observed in the case of intermediate ramose inflorescences and may be attributed to differences in metabolism. It is well known that the upper ear of multiple-eared plants, usually is the heaviest and as it precedes the lower

[1] Collins, G. N. and C. B. Doyle. Notes on Southern Mexico. *Nat'l. Geog. Mag.* March, 1911. Pp. 301-320. Illus.

ears in flowering it would seem to be the better nourished.

It seems not unreasonable to suppose that vigor would increase or favor a tendency to branch while severely unfavorable conditions certainly would result in the suppression of branches. However, if this were the whole explanation of the variability in branching, the general unfavorable conditions which caused suppression of branches should result also in a reduction of the size of the ear with the result that unbranched ears of progenies grown from a branched parent would be smaller than the branched ears in the same progeny. Such does not prove to be the case; in fact, the contrary seems to be true and if external environment is to be considered as a factor in the production of branches it must be assumed that this factor affects only branching rather than vigor in general.

While environment may be an important factor in the suppression or development of branches, adjacent plants in a row undoubtedly have a very similar environment and when one plant produces branched ears, and the next unbranched ones, the change must be in the nature of a threshold effect where small environmental fluctuations have acted in the same direction with factors controlling branching. If this be true then the branched progenies of unbranched ears, produced in progenies grown from branched ears, would be expected to have fewer branched-eared plants than the progenies grown from their branch-eared sibs.

An examination of the pedigree chart shows that the progenies from unbranched ears in the early generations had fewer branched ears than the progenies from branched sister ears but that in the later generations no such difference is maintained. In fact, the only unbranched progeny in the later generations, directly descended from the original branched ear, was from a branched-eared parent. There is little to indicate, therefore, that in the later generations the difference between the branched and unbranched condition is heritable and the failure to develop branches in this particular line must be attributed to accidents of development.

As the chart shows, five progenies were grown from the self-pollinated plants of the original sowing and with a single exception all the branched ears thus far obtained are descended directly from only one of these five progenies.

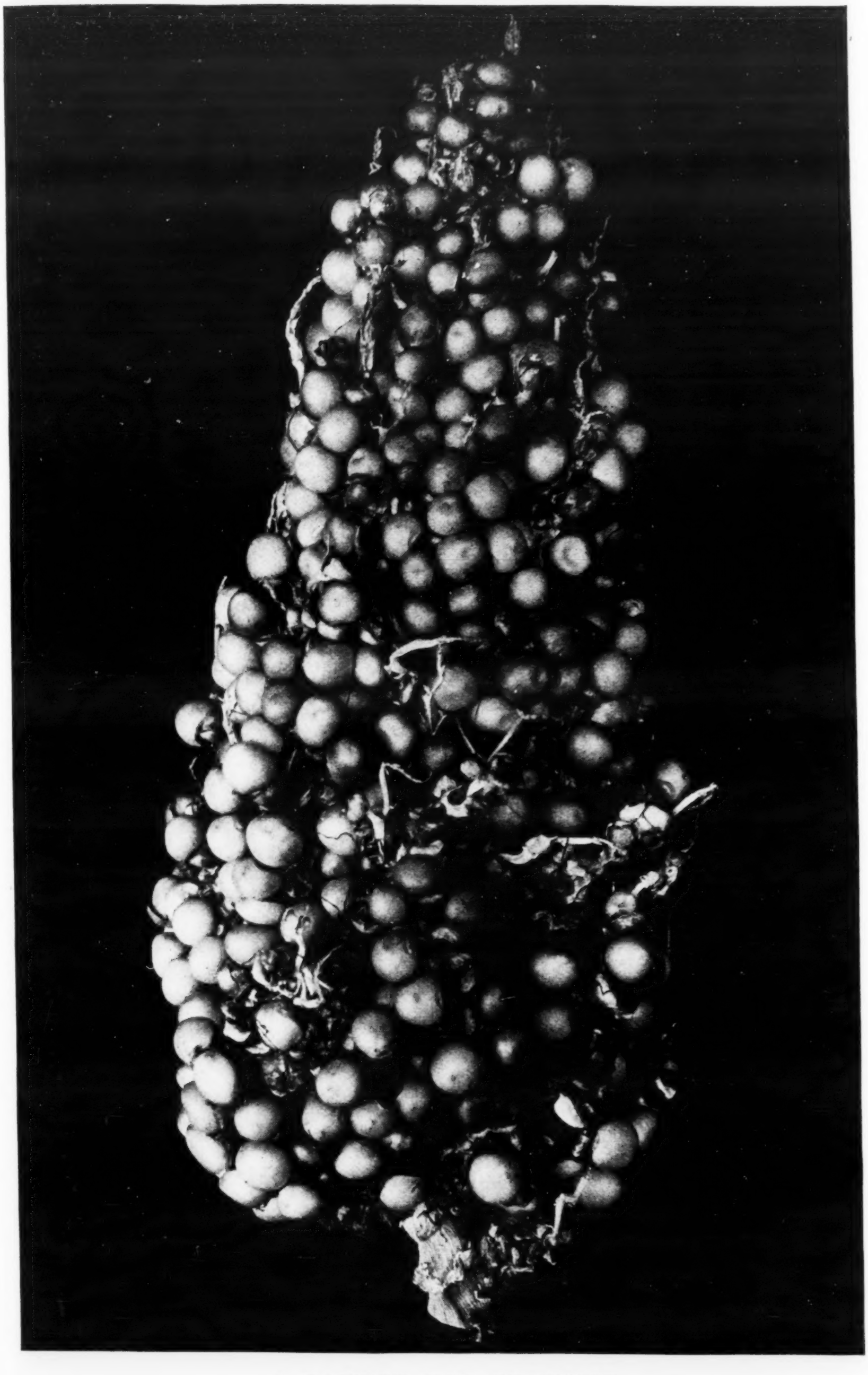
The exception appeared in the third generation of continuous inbreeding of the line marked X in Figure 5. The pedigree of this line is too extensive to publish, but 104 progenies have been grown, 103 of which have produced no branched ears and the other, one plant with a branched ear and twenty-six plants with normal ears.

Seventy-four progenies representing six generations have now been grown from the eighty-eight plants of the progeny that produced the first branched ears and from these progenies the following generalizations are possible:

The progenies of branched-eared plants have, with a single exception, always produced some branched-eared plants and since the percentage of such plants usually is low it is not certain that this exceptional progeny which comprised only eighteen plants, would not have given some branched ears had a larger population been grown. In this case if the expected ratio is assumed to be 4.8 unbranched to 1 branched (the ratio closely approximated in sister progenies) then the observed ratio of 18 normal to 0 branched plants departs from the assumed by an amount which would be expected to occur as the result of chance about once in fifteen times. In the entire pedigree there are thirty-five cases where progenies have been grown from self-pollinated normal plants that had branched-eared sibs. These progenies are not of the branched line shown in Figure 5 and if some of the unbranched ears of these progenies are heterozygous for branching two classes

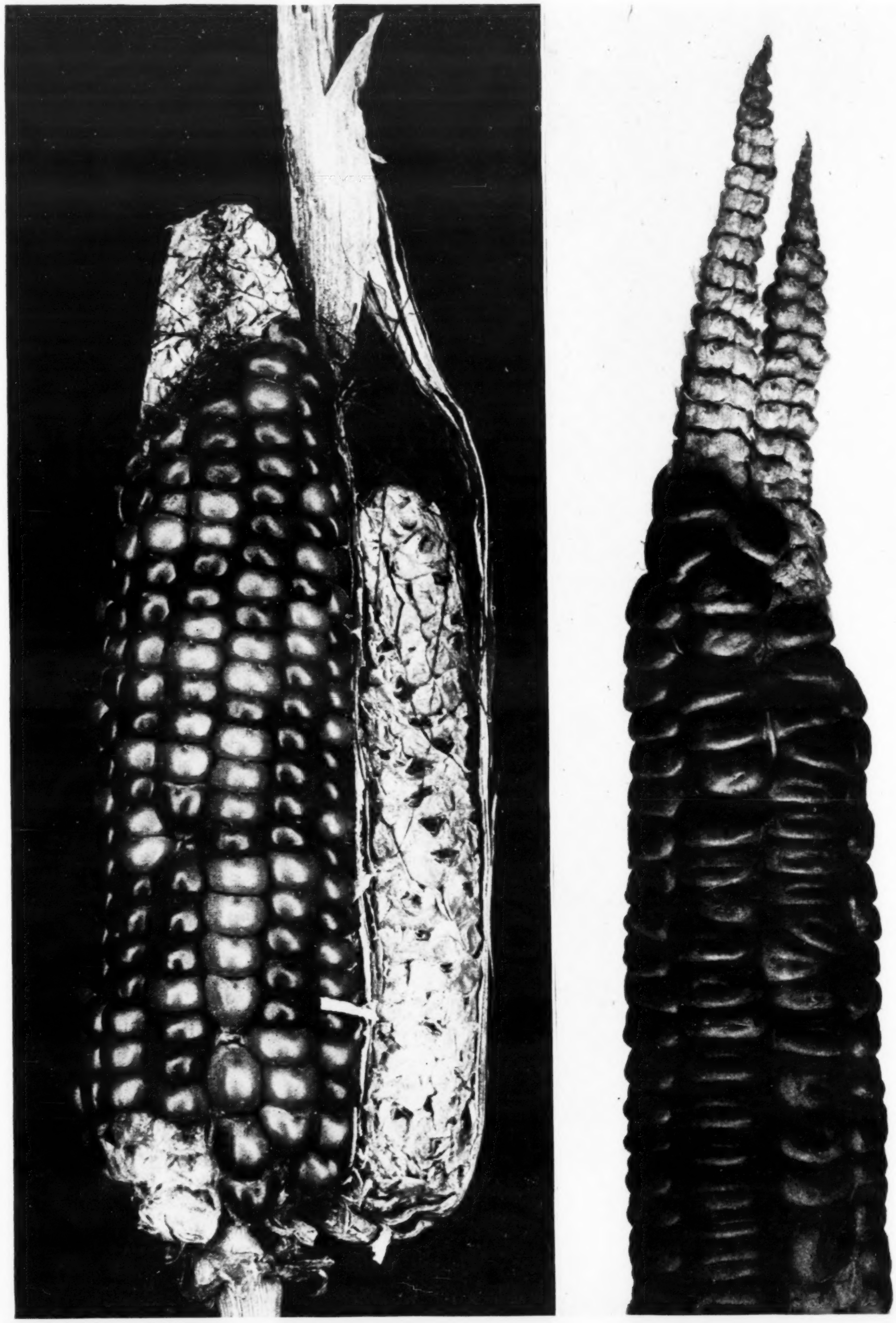
A "BEARSFOOT" EAR

FIGURE 1. Bearsfoot or fasciated ears are one of the commonest abnormalities of maize, and have furnished one explanation of the origin of the normal unbranched form of ear. Some authorities consider the many-rowed ear of maize to be the result of fasciation of the branches of an inflorescence such as shown in Figure 3 (right), and ears such as the above are considered to be examples of imperfect fasciation where the component members have divided or failed to unite.



A RAMOSE EAR OF MAIZE

FIGURE 2. This abnormality consists of numerous branches which decrease in length from the base to the apex of the ear. The normal unbranched ear is considered by some authorities to have arisen through the reduction of the branches of such a ramose inflorescence to paired spikelets. The inheritance of this form of branching is relatively simple and its reappearance after hybridization with the normal form can be predicted with accuracy.



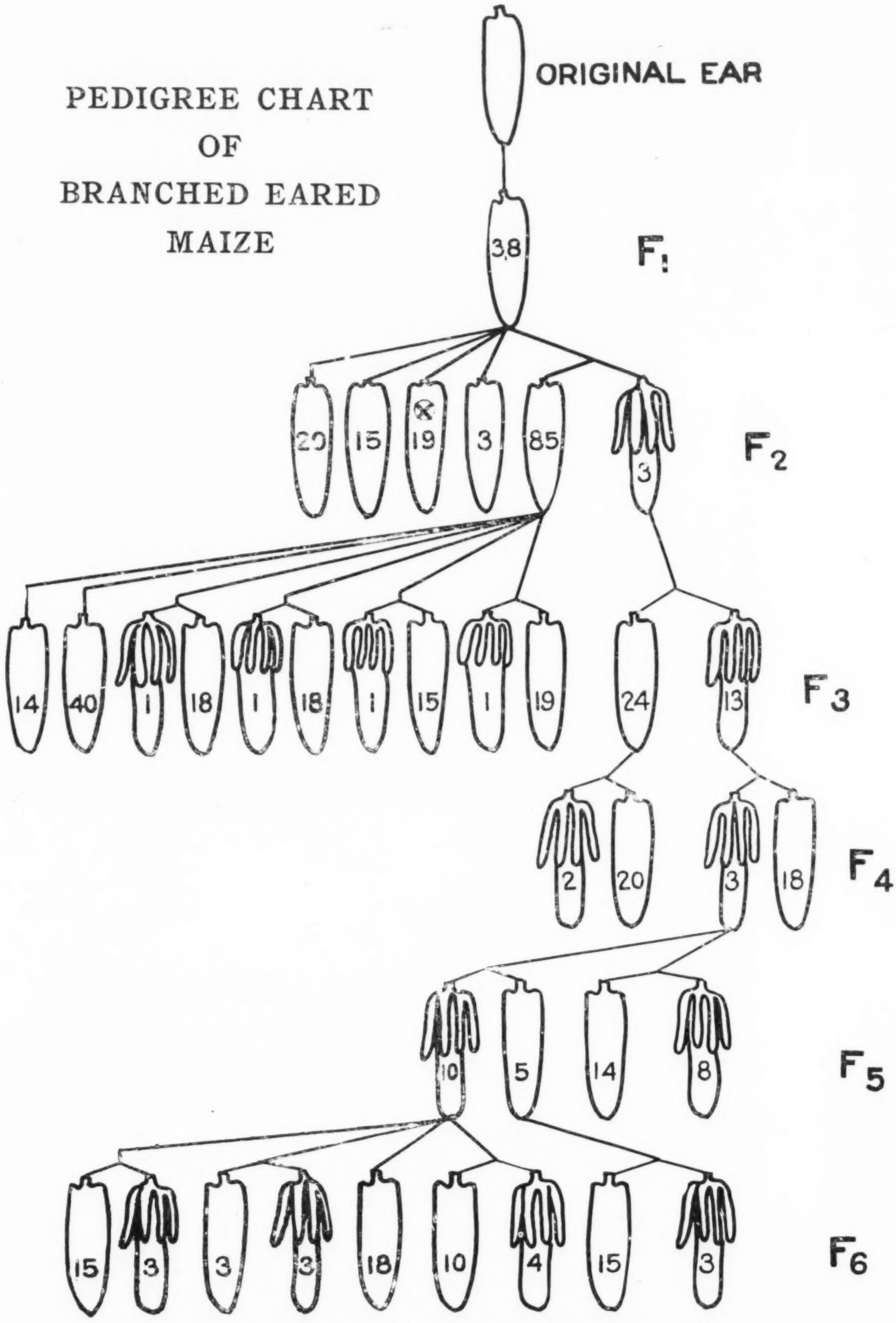
TWO TYPES OF BRANCHED MAIZE EARS

FIGURE 3. On the left is shown a form with branches enclosed separately in husks, like those of the principal ear. This type of branching seems to be inherited in much the same manner as that of the Pawnee Indian variety (Frontispiece). On the left is a partly bifurcated ear of maize, a type which strongly suggests that the eight-rowed ear is the result of the fusion of two four-rowed branches. This form of branching may be the same genetically as the "bearsfoot" branching shown in Figure 1.

TWIN EARS OF MAIZE

FIGURE 4. This ear was found at Tuxla, Mexico, under the name of "Quachi," a native word meaning twins, such double ears being common in the variety. This type of branching is known to be inherited, but the manner of inheritance has not yet been determined.

PEDIGREE CHART
OF
BRANCHED EARED
MAIZE



THE INHERITANCE OF BRANCHED EARS

FIGURE 5. The ears bracketed together are from the same progeny. In each case the number of plants bearing ears of the type shown is indicated on the diagram. Thus in F_6 the right-hand pair of ears represents a progeny of eighteen plants, fifteen of which bore unbranched ears while the other three bore branched ears. From the ear marked X in F_2 three generations of progenies were grown with continuous inbreeding; in all, 104 progenies. Only one of these progenies, in the third generation, produced a single plant with branched ears, along with twenty-six normal-eared plants.

of progenies are to be expected—those having some plants branched and those without branched plants. Of the thirty-five progenies, eight produced some branched-eared plants and twenty-seven only normals.

From the ratio of branched to normal-eared plants in the branched-eared strain shown in Figure 5 it seems clear that only about one-fifth of the plants in lines carrying the factors for branching exhibit the trait. If this be true for the Pawnee population as a whole, then the expected ratio of branched to non-branched progenies in a population from the self-pollinated non-branched plants with branched eared sibs would be 2.8 to 1, while the observed is 1 to 3.4. This latter ratio closely approximates that expected on the basis that branched ears result from the combination of four recessive factors and that the progenies tested were heterozygous for all of them, a condition which fails of support on other counts. With the small number involved it seems idle to speculate further on a possible factorial analysis especially since linked factors or even chromosome reduplication may be involved.

A single line from one of the eighty-five unbranched ears occurring later in the pedigree has been followed for two generations without branches but such cases require no especial explanation.

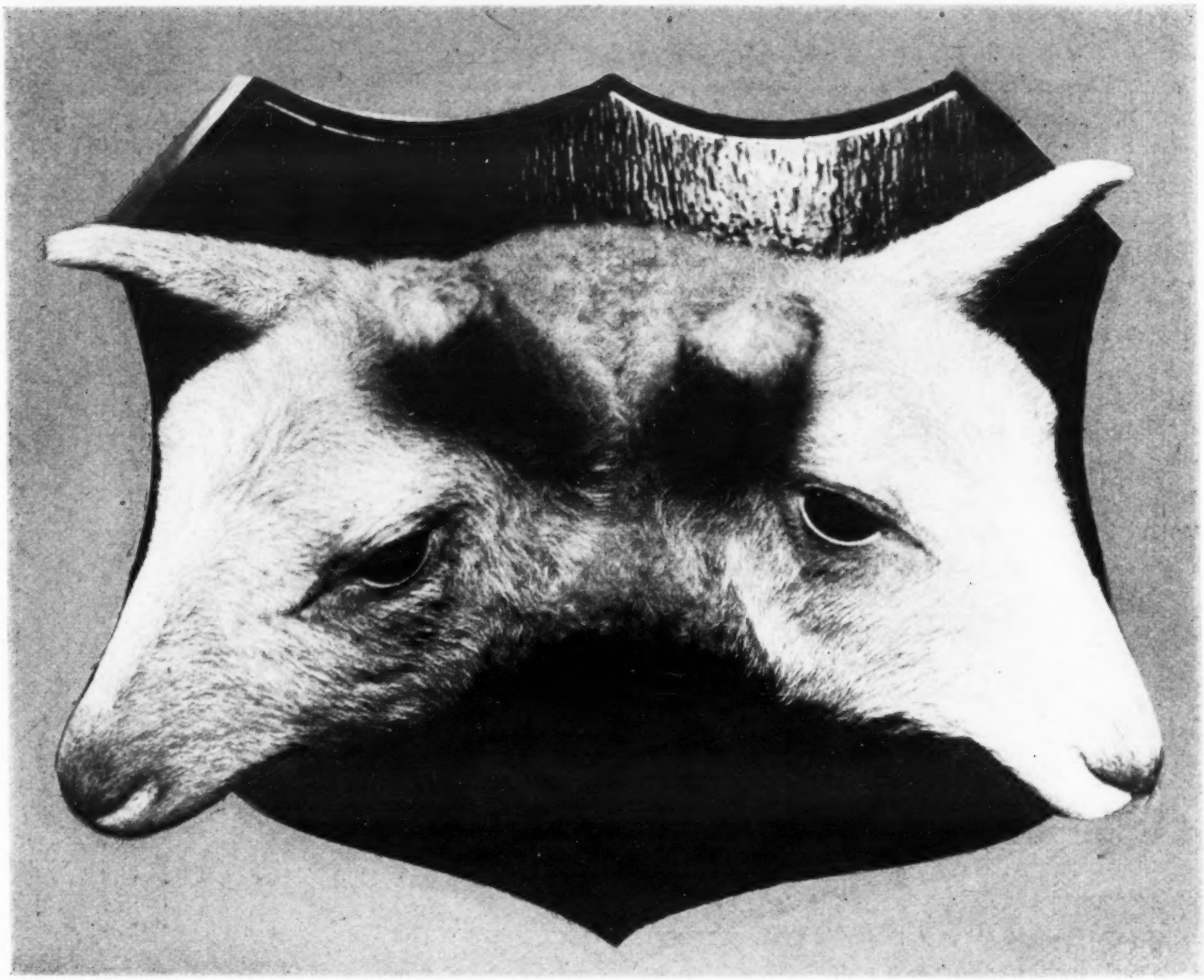
It is clear from the pedigree of the branched ear shown in Figure 5 that a line has been isolated from the Pawnee strain which can be relied upon to produce some plants with branched ears irrespective of the nature of the immediate parent. There can be little doubt that this type of branching is an inherited character for which the original branched ear was homozygous. Repeated self-pollination does not serve to stabilize the amount of branching and the percentage of non-branched plants does not decline. The variability in branching, therefore, cannot be attributed to the influence of hereditary modifying factors and must be considered as a phenomenon of expression rather than transmission.

Some of the progenies of unbranched plants having branched sibs related to but not of the above line plainly are heterozygous for the branched character while others seem homozygous for its allelomorph but the ratio of heterozygous to homozygous progenies is not orthodox. This behavior, however, indicates that the branched character is recessive to the normal form and permits the prediction that all self-pollinated branched ears will produce some branched-eared plants but the uncertainty with which such plants appear renders this character of little value in testing linkages. The fact must not be overlooked, however, that the mode of inheritance of branched ears is characteristic of a large class of characters which seem so delicately balanced as to require some special conditions in ontogeny for complete expression. That internal developmental factors, quite aside from external influences, play a large part in the expression of structural characters must be recognized and the accumulation of data on the inheritance of the more regular characters should not be allowed to obscure this fact. Such characters are to be expected in view of the complicated chemical reactions involved and should not be urged as examples of non-Mendelian inheritance even though in these cases the existence of stable hereditary units can not be demonstrated.

Mendelian Dominant, Or Maternal Impression?

A schoolmaster wrote the following criticism on the edge of a boy's report card: "A good worker, but talks too much."

When the father signed the report and sent it back the card bore in addition to his signature this report: "You should hear the mother."—*Judge*.



A TWO-HEADED LAMB

JOHN ROBERTSON

Tufta Harry, Orkney Islands, Scotland

THE accompanying photograph is of a preserved and mounted specimen of two heads of a lamb on one neck and united at the bases of the skulls. The local veterinary surgeon, Captain Eady, was called out to attend the case in the neighborhood on April 10th, 1922, and as far as could be ascertained the ewe showed no apparent abnormality on first examination, one head and two forelegs being quite normally presented in the passage. On further examination a second head could be traced to the same neck and, after careful munipulation, the lamb was delivered, breathing alternately from one head to the other. As the owner, Mr. Smith, of Winksetter, had no wish to keep it alive, the lamb was destroyed by the veterinary. The post mortem revealed a perfectly normal lamb, except for the two heads.

A second lamb was also delivered. This was normal and alive. It is curious to note that the same ewe was attended by Captain Eady on May 4th, 1921, and a dead lamb removed with some difficulty. Had this anything to do with the present freak of nature?

BIOLOGY IN HUMAN PROGRESS

Urbanism the Underlying Cause of Social Fermentation and Decay of Civilization

O. F. Cook

U. S. Department of Agriculture

THE time may soon come when civilization will be studied as a branch of biology, and compared with other social phenomena of the plant or animal world. The limiting factors of civilization are being sought by many writers in actual conditions and influences, instead of relying upon abstract ideas or believing that progress must run in fixed cycles of growth and decay. This is a constructive tendency that may gain for our civilization a sense of scientific foresight and powers of conscious adjustment, to avoid mistakes that have destroyed preceding systems.

Civilization is the world we live in, the aggregate product of human evolution, down to the present time. The tendencies of human evolution will determine the future of our system of culture and of our posterity, as the fates of other systems and other peoples have been determined in the past. War is the traditional destroyer of peoples, but military supremacy does not keep nations from decay or from suicidal courses, as is seen in ancient Rome or in modern Germany.

Limiting Factors in Human Development

Some of the early systems of civilization were self-limiting for agricultural reasons. The production of food could not be maintained after the forest vegetation was exterminated, because the grasslands that replaced the forests could not be cultivated by the primitive methods of agriculture. This would explain why many primitive cultures were abortive, and why the most ancient and enduring civilizations were those of Egypt, India and China, in the flood-plains of rivers where the soil is continually renewed. Some of the former centers of civilization are now entirely deserted, or the populations have changed so that the capable races of ancient times are only doubtfully recognized among the modern inhabitants.[1]

Urban deterioration of advanced races is another biological factor that helps to explain why civilizations are self-limiting. During the agricultural period the development of a race may be supposed to continue, since the more capable families are gradually improving their environmental conditions, and have better chances of survival. But when the period of urban civilization is reached the tendencies to race improvement are reversed. The capable families are attracted to the cities, where conditions are less favorable for normal individual development or for maintaining the capable stocks. Talented individuals of an advanced race are not more likely to leave descendants, but to form a smaller minority in each generation, as Galton recognized.

If the effects of urbanism were more clearly recognized as an agency for the elimination of less desirable stocks, the city might serve an important function in human development, but superior families that go to the city and deteriorate are a permanent loss to the race. The outlook for eugenic progress is small if the urban

[1] Cook, O. F. Milpa Agriculture, a Primitive Tropical System. From the *Smithsonian Report* for 1919. Pp. 307-326.

tendency to selective elimination of the more capable families is to remain dominant in our civilization. At least it is a hopeful sign that restrictive effects of urbanism on human development are being recognized more clearly. An article by Dean Inge on "Democracy and the Future," in the *Atlantic Monthly* for March, 1922, contains an acute analysis of the effects of urban industrial conditions as responsible for mental as well as for moral deterioration, and for marked anti-social tendencies in Europe and America.

More and more I am driven to the conviction that social unrest is an ineradicable disease of town life. The war is between town and country; between the countryman, who lives under natural and wholesome conditions, and the townsman, who lives under conditions which are neither natural nor wholesome. Allow me to quote from an American writer, Mr. Alleyne Ireland. "The average voter in a large town brings into politics a mentality utterly different from that of the country voter. It is the mind of the propertyless wage-earner; of the clerk, of the shop-assistant, of the day laborer; of a man herded with other men and profoundly affected by the herd-instinct; of a man of weak individuality; of a man who spends his working hours doing things for other people, and his leisure hours in having things done for him by other people; of a man whose life is passed in surroundings entirely created by machinery, and in circumstances where his free will is perpetually constrained by the contagion of an artificial environment; of a man who knows (or at any rate, of whom it is known) that, if he drops dead while at work, he can, in normal times, be replaced in an hour by another man who will do just as well."

Mr. Ireland goes on to show that such a man, whose whole existence is passed in the feverish occupations of earning wages and spending them, who is never brought into contact with the real origins of things, and is incapable of realizing the mesh of causation in which he is entangled, naturally looks to government to supply him with all that he needs, and to redress all his grievances. The two nations of which Disraeli spoke in *Sibyl* are not, as he supposed, the rich and the poor; they are the town and the country. And industrialism has thrown the balance of power into the hands of that section which, through no fault of its own, is stricken with an incurable malady.

This is what my medical friends would call a sombre diagnosis. It is very sombre indeed, as regards my own country, with its congested towns and limited rural area. It does not seem to be a disease which any form of government can cure. A Russian revolution would cure it in a way—by killing the patient. The evils of industrialism might, no doubt, be terminated by exterminating the industrialists. But the townsman of Europe and America has no mind to commit suicide, and unlike the Russian, he is capable of sane reflection. In America he will probably come round to the policy which has long found favor in Australia and New Zealand; he will stop immigration from the backward races.

New Zealand has escaped the evil of large cities, and has kept its population almost exclusively British. This policy has retarded the development of the country; and those who, like many Americans, are affected with a pathological worship of mere numbers, will think that the New Zealanders have not made the most of their opportunities. The case is arguable on both sides. Personally, I am disposed to think that the old American stock, which, until that disastrous Civil War, was the finest in the world, has been too much diluted during the last half century with infusions of inferior blood. But America, the most fortunate of countries, may make with impunity mistakes which would be disastrous in older nations.

I have made a diagnosis of the malady from which all civilized nations are suffering. I have suggested no remedy, because I do not know where the remedy is to be found. If the disaffection of the townd-weller continues to grow and fester. Democracy may fall, and civilization with it.

Effects of Environment

Nevertheless, the hope of finding a remedy is greatly increased when the cause of a disease is determined. If more of our economists and constructive reformers could see with Inge and Ireland that urbanism is responsible for social derangements, measures of improvement might be considered with better purpose. The moral and political dangers of urbanism have been recognized, of course, for centuries, and hope has been placed in moral and political remedies, but these are proving as ineffective in American cities, as in other parts of the world.

The effects of different environments upon the growth of plants and animals are being determined by scien-

tific methods, so that the best conditions and treatment may be provided, to facilitate the production of food and industrial raw materials, but human biology is an undeveloped branch of the science. Little consideration is given to the effects of the human environments, except to avoid the limits of starvation or disease. To raise a good crop of corn or cotton we know that the best seed must be selected and that the most favorable cultural conditions must be maintained, but the need of similar precautions in human development is neglected, even in the educational systems of advanced nations.

The effects of urban environment are like those of parasitism among plants and animals, which biologists treat as a degenerative condition. Compared with free-living types, parasites are inactive, inept, and infertile. In many different groups where parasitic habits have been adopted the general result is the same. Many organs and functions that in free-living groups are highly developed become weakened or are lost entirely among sedentary parasites. Cities are parasitic not only in being supported from the outside, but the arts of self-supporting existence are lost, as with other parasites.

The difference is not merely that the farmer works in the open air while the city cousin works in a shop or an office. The physical conditions may be important, but many other features must be considered in comparing the environments and determining their effects. Contacts with nature are enforced by the conditions of rural life. The change of seasons, the diversity of crops and weeds, and the care of different kinds of domestic animals, to say nothing of the wild flowers, birds and insects, make the life of the farm utterly different from the life of the city. The farmer's work is not a simple routine, but endlessly varied and requiring a continuous exercise of judgment to decide what must be done first, and to fit the different tasks together to the best advantage. An active farmer takes a vastly more complex, exacting and continuous responsibility than the urban worker who does the same thing every day, and has no responsibility when "off duty." The mind of the urban worker is formed by the uniform reactions of machinery rather than by the varied contacts with nature or with living things. "We take our industrial and commercial standards from the machine," as one writer says, and chiefly for the reason stated by Inge, that the urban worker is "a man whose life is passed in surroundings entirely created by machinery." The contacts would not be so restricted, if urbanism were not carried to excess.

The Basis of a Permanent Civilization

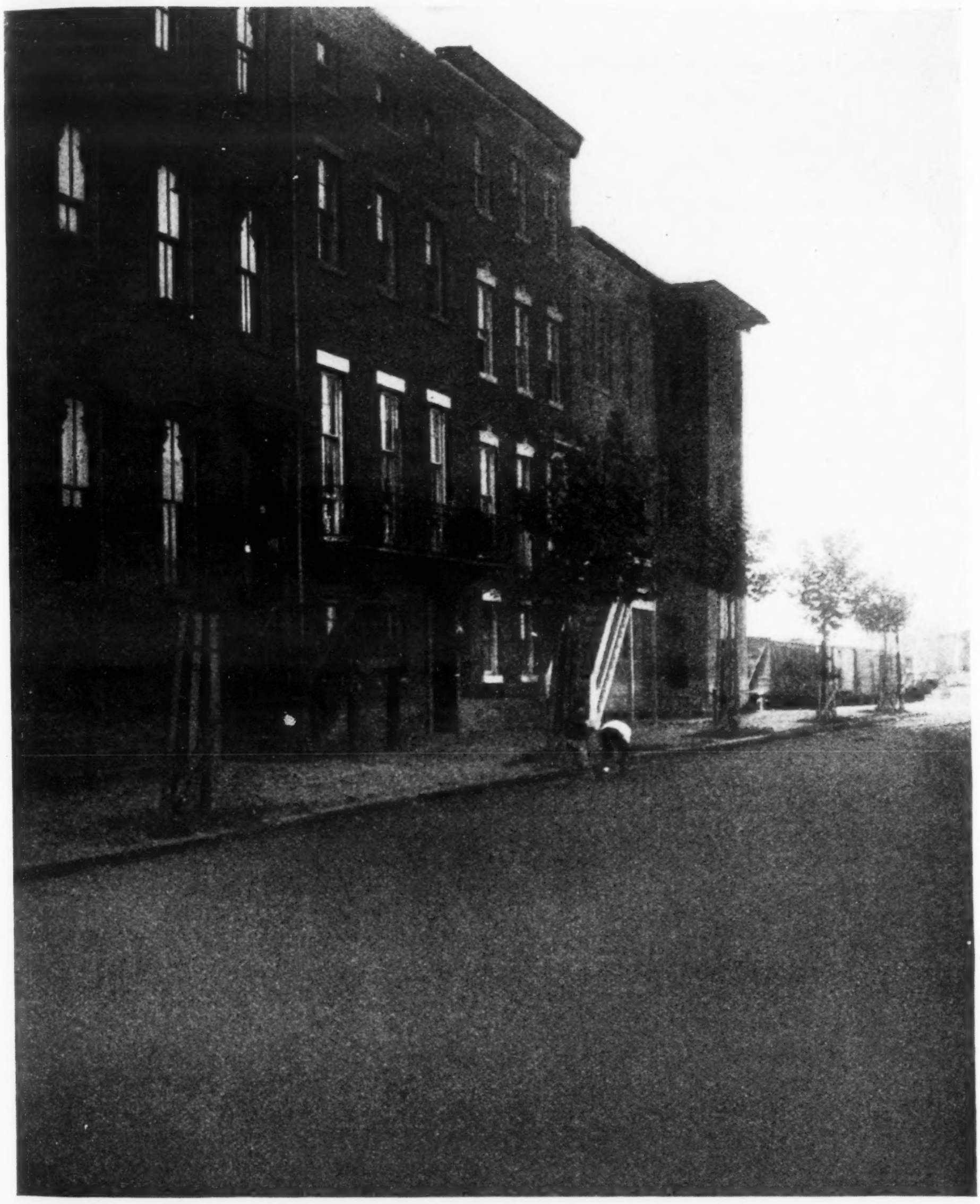
It is a mistake to suppose that civilization is a matter of cities alone. Agriculture is the constructive stage of civilization, urbanism the stage of deterioration and decline. The conditions that permitted the development of the arts and social adjustments to the point where cities of non-producers could be supported, were the conditions of primitive agricultural life, with families living separately upon the land and children associating with their parents so that the experience of the successive generations was accumulated. Many primitive peoples went prematurely into urbanism by living in communal dwellings or crowded settlements and restricted their possibilities of development, because the children of such communities herd together and have less association with their parents.[2]

The failure of ability to develop under the urban condition is seen in the waste of youth that each generation laments. Ability in the country may not be developed, but is likely to

[2] Cook, O. F. Definitions of Two Primitive Social States. *Journal of Washington Academy of Sciences,* Vol. II, No. 5, March 4, 1912.

THE RURAL ENVIRONMENT

FIGURE 7. "It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing in the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. . . . There is a grandeur in this view of life, with its several powers, having been originally breathed into a few forms or one; and that, whilst this planet has gone cycling on according to the fixed laws of gravity, from so simple a beginning, endless forms most beautiful and most wonderful have been, and are being, evolved." —*Charles Darwin.*



THE URBAN ENVIRONMENT

FIGURE 8. "The average voter in a large town brings into politics a mentality utterly different from that of the country voter. It is the mind of the propertyless wage-earner, of the clerk, of the shop assistant, of the day laborer, of a man herded with other man and profoundly affected by the herd instinct, of a man of weak individuality, of a man who spends his working hours doing things for other people, and his leisure hours in having things done for him by other people; of a man whose life is passed in surroundings entirely created by machinery, and in circumstances where his free will is perpetually constrained by an artificial environment, who is never brought into contact with the real origins of things, and is incapable of realizing the mesh of causation in which he is entangled."—*Alleyne Ireland.*

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be transmitted, while either development or transmission of ability is less likely in the city. The ability that fails of transmission is a permanent loss to the race.

If urban populations did not deteriorate, but maintained a normal rate of increase, the cities might fill up, and a balance of urban and rural populations would be established. There would not be a continued draft upon the country, if the urban conditions were not destructive. But always there are inducements for capable men in the city, the recent arrivals competing successfully with the less energetic or resourceful natives of the city, and sending for their rural kinfolks to come in and share their prosperity, in the easier life of the city. The rural immigrant sees it as an advantage to him that the urbanites are less capable, not realizing that his own children will share the same limitations. Thus it is in the nature of cities to be calling always for more people, who go in and are consumed, the parents sacrificing their children as in the days of Moloch. The ancient rural gods were supposed to be satisfied with the blood of the first-born, but our urban dieties take the whole family. It is our immoral custom to sacrifice posterity to "prosperity." The limited urban environment and the selective draft upon the rural population work together to deplete the human stock. The race suffers as a whole, until the basis of civilization is destroyed. The "cycle of civilization" comes to an end, because the adjustments of a complex social structure are not to be maintained by a depleted and incapable population.

The urban environment is too restricted for the normal exercise, growth and satisfaction of the human instincts, senses and abilities. Full development of the physical, mental and social stature is seldom attained, and everybody is discontented who feels that he is being deprived of a normal existence. Rich urbanites may suffer from this feeling of inadequacy as acutely as the poor, and with as little understanding of the cause. Lack of practical judgment and aberrations of many kinds, in amusements, dissipations, narcotics, crimes and conspiracies are to be reckoned as symptoms of urban deterioration. Nervous prostration of the individual and radical upheavals of urban masses may be traced to the same underlying cause, the monotony and tension of urban existence. The danger of destructive mass movements at the present time is increased by the doctrine of socialism that ascribes all of the urban lesions to economic inequality. Because abuses exist it would abolish the institution of private property, and especially property in land. The socialist remedy for urban deterioration would make the city more actively parasitic upon the country and destroy civilization more rapidly. Only disaster could be expected through the control of the country from the city, which socialism would establish.

The course of history shows no remedy for urban deterioration and decay, no solution of the urban problem. Probably there is no artificial way to make good the effects of limited environment in restricting the development of the individual and causing the deterioration of the race through adverse selection. Urbanism is a dysgenic condition. "Great cities are the sink holes of the human race, the places where the blood deteriorates, sterilizes and runs out." Urbanism needs, of course, to be studied and its lesions carefully determined, but a phenomenon that is to be investigated in detail must first be recognized.

The American Ideal

America, fortunately, is not yet urbanized to the extent of the industrial countries of Europe. With us there are still living in the country many people who think and are learning practical ways of restricting the commercial parasitism of cities. This

effort is misunderstood, of course, by those who believe that the country owes the city a living, and also by those who think of farming as only one trade, one branch of "industry," and deserving of no special consideration. In reality agriculture is not a mere branch of civilization, but is the root of the whole tree, the root that has produced and now has to support all the branches of urban activity, along with the idle and parasitic elements that figure so largely in urban populations. It is beside the point to complain that the man who tills the soil is "compelled to bear the burden of the social structure," since there is no other way for the social structure to be supported. The tree must have its root, and the root must function if the tree is to grow, but parasites may distort or kill the tree, and our modern civilization is rather heavily infested. The branches are fringed with mistletoe, and many kinds of broom-rapes and beechdrops are sapping the root. Only as we assess the burden of urban parasitism can we begin to comprehend the true possibilities of a symmetrically developed rural civilization, which is the American ideal.

The purpose of founding a rural civilization, expressed with so much conviction by Washington and Jefferson, has been relaxed. We are tolerant and even boastful of our large cities, and take it for granted that sanitation and engineering improvements will avoid the deterioration of urban population. Our mental habit is to ignore the dehumanizing effects of urban industrial conditions and then to be surprised and horrified by the barbarism and brutality that appear, as in the relations of capital and labor. Germany was most scientifically urbanized and stood in the first rank of industrial and commercial nations, but staked all her attainments on a predatory war.

If we could accept the diagnosis that the urban state of mind, "the worship of mere numbers," is pathological, eugenics and other human welfare considerations would begin to figure in social and economic studies. Conditions and measures would be judged by the eugenic standard of improvement of the race. We would see that the city as a human environment is a mistake, and the question of abating the urban malady of civilization might be approached on constructive lines. One of the first steps would be to develop a better system of education, so that people would not be trained merely for the city, or for a "semimonastic" existence with late marriages and few children. Some talk there has been of country life education, but little of the reality as yet, for the educational value of country life has still to be recognized by the urban specialists who dominate the educational profession.

The other problems would be solved if more of our capable young people became intelligent enough to remain in the country. The adverse selection will go on as long as the schools are procurers for the city. Thousands of urbanized teachers are telling the children every day, even in rural schools, that the real life is in the city. To fire the mind of youth with the idea that the great prizes of life are to be captured in the city is essentially immoral, and must be condemned and counteracted as a betrayal of the race. Undoubtedly the life of the city often is much easier than that of the country, but certainly the ease and luxury of the city are not the highest ideals, and urbanism for the race is clearly suicidal.

GLANDS AND THEIR FUNCTION

A Review

GLANDS IN HEALTH AND DISEASE, by BENJAMIN HARROW, Professor of Physiological Chemistry at Columbia University, Pp. 218. Price $2.50. E. P. Dutton & Co., New York. 1922.

THIS little book of 218 pages contains a large amount of information in compact and readable form. It is intended as a popular exposition of the important field of the glands of internal secretion in their relation to bodily function and growth. The author has made a sincere effort to bring the subject within the grasp of the general reader and has for the most part been successful, although the subject is one through which it is most difficult to steer a straight course, when it comes to the problem of popularization. He is, above all, to be commended for his sanity and for his stern refusal to be enticed into sensationalism however well it might strike the popular fancy. This scientific attitude is the keynote to the book. There is also a very useful bibliography that will prove of value to many.

He gives a very lucid discussion of the nature of the endocrine glands in general, explaining the manner in which they function and dealing with such timely questions as their relation to vitamines. Very properly most attention is given to the thyroid, pituitary, pancreas, the germ glands, and the adrenals. His treatment of the thyroid gland is typical of the scope of the work. He describes its location, considers thyroid deficiency diseases, deals with the effects of oversecretion, and then proceeds to a discussion of the general principles of metabolism and the way in which the thyroid gland is involved. The more important lines of experimental work are discussed and an account of the biochemical aspects of the gland concludes the chapter. Throughout he makes specific reference to the work of various authors—a necessary treatment in a subject of conflicting views such as this. The chapter on the pituitary gland is handled in much the same style, and the same may be said of the book as a whole.

It is not surprising that in a subject so new and so full of conflicting opinions the author should lay himself open to criticism here and there. If only for the sake of conscientiously playing the part of reviewer we may offer a few criticisms. For instance, he says. "The pituitary body like the thyroid consists of two parts, two lobes." Not only in this but in later statements he shows ignorance of the more recent work in which the intermediate lobe and the pars tuberalis portions have been added to our knowledge of this composite gland or rather collection of glands. In any case the comparison with the homogeneous thyroid is rather unfortunate; but this is merely a fault of expression, because he discusses most fully and entertainingly the differences in function betwen the anterior and posterior lobes.

We can look with tolerance on such misuse of words as that of calling the production of ova by the ovary a process of secretion. In the chapter on the relation of the ductless glands to one another one might take issue with the statement that "removal of the thyroid gland causes enlargement of the pituitary and *vice versa*." The removal of the thyroid gland does cause hypertrophy of the *anterior lobe* of the pituitary gland, but the removal of the pituitary gland causes a reduction in size or even atrophy of the thyroid gland. We must take exception

to his statement that "castration does not seem to have much influence on the thyroid gland." Koch has shown that it becomes very small in castrated members of the skoptch sect in Russia and Roumania.

The author gives a very good account of the interesting rejuvenation experiments by implantation of germ glands, vasectomy, and use of X-rays, and gives a fairly full discussion of the work of Varonoff, Steinmach, and others. He might well have mentioned the interesting work of Dr. Stanley of the California State Prison at San Quentin.

Dr. Harrow also presents an interesting and well balanced account of the controversy betwen Cannon and Stewart upon the response of the adrenal glands to emotional excitement. He makes a well justified attack upon the extremists who so strongly urge the claims of organotherapy.

In this righteous war against sensationalism and quackery in which all lovers of sanity and truth bid him "God speed" he may now and then unjustly chastise thoroughly "law abiding" scientists as when under the heading *A Bit of Fancy* Dr. Harrow quotes some highly spiced newspaper accounts of the New York meetings of the International Congress of Eugenics, as they were reported at the time. The reports were quite wierd enough as all will agree; but a careful reading of the two volumes of published proceedings of the meetings fails to reveal the erratic statements attributed to the worthy scientists. Dr. Harrow in his eagerness to defend truth and sanity should not allow himself to be drawn into a sham battle with men of straw created by even "one of New York's very respectable newspapers." It is rather disconcerting to have a scientist side with the public press in its ribald laughter at the fancied vagaries of scientists. Heaven knows scientists have enough real vagaries to answer for. All this grows out of the author's healthy and very praiseworthy attitude of critical skepticism and he deserves the highest praise for sparing us the mass of half-baked wild hypotheses that some recent writers of books and quasi-popular articles have foisted upon a gullible public. So we say "all strength to his arm even though he may now and then hit an innocent and highly respectable scientist."

The author has given in his preface a warning of his critical attitude in the following readable passage:

> Monkey glands; clever men and stupid ones; glands as the cause of crime; the origin of races; the mentally unbalanced; many acute diseases; the bearded lady, the fat boy and the midget; all these and many more have been dealt with under the subject of glands of internal secretion. As in any subject that fires the popular imagination, fact and fancy have been mixed—several drops of fact have been diluted with many drops of fancy. The achievements, judged by rigid scientific standards, are no more than modest but the possibilities are limitless. It is because of these vast possibilities that an imagination, not sufficiently tempered by self-criticism, is apt to enlarge a molehill into a mountain.

This is a fine attitude—the only point of view from which one can write a really worthwhile book on any phase of science. The need for such scientific caution is especially great in this field of work where the temptations are so enticing, and Dr. Harrow has given us an admirable book worthy of the highest commendation. It is a compact, up-to-date, and truly scientific exposition of this subject. For the most part it is a highly entertaining book. In places the beginner might get rather deep into technicalities, but the author has done all that one could expect him to do toward making this complicated subject understandable. He has carefully qualified his statements by quoting conflicting views of different authorities. While this may bewilder readers who demand dogmatic and sensational as-

sertions, the public should learn that science cannot deal with reality in that way. This book is an admirable example of scientific candor, accuracy, enthusiasm and restraint. We can only hope that it may be given the widest currency.

BENNETT M. ALLEN,
University of California
(Southern Branch)

The Economic Value of Pure Bred Cattle

Seventy-five per cent of the dairy bulls in use in the United States are either grades or scrubs. They are bulls from ancestry that has not been bred generation after generation for large and economical production of milk and butter fat. This fact, says the United States Department of Agriculture, accounts for the low average production per cow in this country.

In 1921, there were less than 80,000 pure-bred bull calves registered by the breed associations. But this probably does not represent half the pure-bred bulls born in 1921. The 80,000 or more that were not registered, in addition to a part of those that were registered, were probably slaughtered because their breeders were not able to market them profitably. This is because the average farmer is not yet convinced of the advantages to be derived from the use of pure-bred sires. If every pure-bred bull calf born in this country were raised, it would take a three or four years' crop of calves to replace the grade and scrub bulls (numbering approximately 600,000) that are being used in dairy herds. When it is considered that not all pure-bred calves are worthy of being used, even on grade herds, and allowance is made for the normal death rate and other factors that enter to cut down the number of pure-bred bulls raised, the above estimate of three or four years could safely be increased to five or six years as the time that would be required to replace the scrub bulls.

Only three per cent of our dairy cattle are pure bred, and the supply of pure-bred bulls would be wholly inadequate if the farmers of the country could only appreciate the benefit it would be to them to head their producing herds with pure-bred sires of good producing strains.

—U. S. Department of Agriculture.

Two Corrections

Owing to a typographical error in the notice of a paper on Campanula, by Lathouwers, in Vol. XIV, number 8, page 345, of this Journal, the last line of the first paragraph was carried over to the second paragraph, with resulting confusion. The second paragraph should begin as follows:

"In a pure line of *Campanula medium* a form called *monantha* appeared. . ."

In the August 1923 Journal, page 209, a case of typographical "crossing over" occurred in the legend to the chart accompanying Dr. Castle's paper on the inheritance of webbed toes. In the last line of the legend it is stated that the character may be carried in the Y-chromosome. This should have read:

"Suggesting that the character is carried in the X-chromosome."

MENDELIAN INHERITANCE IN POULTRY

A Review

HEREDITY IN POULTRY, by REGINALD CRUNDALL PUNNETT, F. R. S., Professor of Biology in the University of Cambridge; Fellow of Gonville and Caius College, etc. Pp. 204; 12 pl; price $2.00. Macmillan & Company, Ltd., London and New York. 1923.

FOR over twenty years the domestic fowl has been the subject of experiments designed to discover, among other things, the mode of inheritance of specific traits. It furnished under the hands of Bateson the first demonstration of Mendelian inheritance in the animal kingdom, and has since contributed information on many of the more important general principles of genetics. Professor Punnett was one of the first to recognize its value as an experimental subject, and from his early association with Bateson to the present time, he has been intimately connected with the growth of knowledge about heredity in fowls. There is no one better qualified than he to write with interest and authority on the subject.

In compiling this book the author, as he tells us in the preface and the text, had a number of objects. He wished to summarize the progress of investigation, to provide a guide to past and possibly future work with poultry, and to present the problems involved in their relationship to the general problems of genetics. His presentation was influenced by an obvious desire to make his book of value to those with both a scientific and a practical interest in poultry. He is particularly aware of the need for impressing the practical man, who in the end supplies the funds for investigation, with the value of research into principles which may lay the foundation for applications to agriculture. The dominating, though unexpressed, object appears to be the introduction of the reader to the principles of Mendelism with illustrative material drawn from poultry breeding.

These objects although difficult to reconcile are in general fulfilled. The greatest success is attained in the last of the purposes mentioned and in the opinion of the reviewer, the book will prove of most value to persons interested in poultry who desire a simple presentation of Mendelian inheritance. Professor Punnett is a master of the art of simple, concise statement as is evidenced in his little volume on "Mendelism" and his article "Mendelism" in the Encyclopedia Brittanica, 11th Edition. He assumes but little familiarity with general biology on the part of the reader and proceeds from simple Mendelism through the more complicated subjects of reversion, multiple factor inheritance, sexual characters and sex-linked transmission to a short discussion of linkage. His illustrations are few, simple and well chosen, and they are in general comprehensible to the layman. The method of presenting each subject is the excellent one of giving first a simple example of the facts as known, then tracing the development of the theoretical explanation and finally, wherever possible, the indication of the application of the principles to poultry breeding. This method is well exemplified in his two chapters on sex-linked inheritance where after a theoretical explanation he shows the application of Pearl's hypothesis of the inheritance of fecundity, and clearly outlines the methods to be used for distinguishing the sex of young chicks by the use of sex-linked characters. He makes no mention of the chromosome theory of sex or linkage. In fact the word chromosome is not to be found in the index. This may be wise in

dealing with poultry where the chromosome situation is not clear, and it will be welcomed by those persons, who being unfamiliar with genetic theory and terminology, react to the word chromosome as a bull to a red flag. It is nevertheless a serious omission in a survey of any genetic subject.

The chief contributions of the book to a summary of progress in poultry genetics are in the chapters on plumage color and structural features, and in the bibliography of one hundred and forty-eight titles. This work of summary was much needed, and Professor Punnett has probably accomplished all that can be done at the present time. He has emphasized the incomplete state of our knowledge and the opportunity and need for further research, and this is generally the chief value of a summary of progress in science. In the text are also added numerous valuable observations of the author which had not been published previously, and which now become a part of the literature of the subject.

In the short readable treatment of the subject which Professor Punnett has given, omissions and simplifications are to the advantage of the reader not versed in genetics. The all inclusive and detailed nature of many books on scientific subjects is often the feature which restricts their appeal to purely professional readers. Without appearing to "write down" to the amateur, Professor Punnett has provided him with an introduction and a guide, while the annotated references will send him, if he is interested, to the original data. The geneticist will find few specific criticisms to make. One which will appear is the confusion of "sex-linked" and "sex-limited" traits (Cf Esp. p. 78). This distinction which has become fixed in American literature, is not clear either in this volume or in the author's previous book, "Mendelism." Chapter VI, on secondary sexual characters appears to suffer from this lack of clarity and from a rather controversial discussion of the author's hypothesis of the inheritance of hen feathering. The hypothesis includes identification of a factor having the mode of transmission assumed for the "W" chromosome (*viz*, from mother to daughter), with the secondary sexual secretion of the ovary. This material does not seem to be on a parity with the rest of the book.

Breeders of Barred Plymouth Rock fowls for exhibition will probably question his statement (p. 128) that "the show cock is usually heterozygous in the barring factor," while the homozygous cock is too light for exhibition. Evidence in support of this contention is lacking so far as the writer knows. The reason for using the "double mating" system by which Barred males and Barred females for show are produced from separate matings, is not to prevent the production of black females by the exhibition type of cock, but to increase the darkness of the male offspring by breeding from females which are darker than the standard shade, and in such matings standard type males are used successfully by both American and English breeders.

Biologists will welcome this book and need have no hesitation in recommending it to their poultrymen friends. With the growing interest of poultrymen in the principles of inheritance, it should have a wide sale, and could be put to good use as a text in a poultry course devoted to breeding.

It is uniform in format with the author's "Mendelism," and exhibits the same high quality of composition and press-work.

L. C. Dunn.

PRODUCTION OF DOUBLE CONE FLOWERS

DAVID GRIFFITHS
U. S. Department of Agriculture.

SINGLE AND DOUBLE CONE FLOWERS

FIGURE 9. Several stages of doubling are shown, from flowers with only a single row of ray-flowers around the base of the "cone" to those with ray-flowers nearly to its apex. It has been found impossible to reproduce the double flowered plants satisfactorily from seed, but greater success was attained with cuttings, the method used being described in the text.

IT HAS been fully ten years since the author found a completely double flowered form of *Ratibida columnifera* near Artesia Wells, Texas. This species as it grows in Texas is often a very different thing from what passes under the same name in the Northern Plains region. There it is usually low and spreading, but in Texas it may often be found 2½ to 3½ feet high, and when growing thickly, quite erect in habit.

The planting from which the stock in question was obtained was a very thick one, covering possibly one-twentieth of an acre, and most of the plants were fully three feet high. In it were all graduations of ray-coloration from pure yellow to deep maroon, the latter predominating. The double flowered forms seen by me were all of the maroon type and varied considerably in the amount of doubling, some plants showing it only a little,

while the flowers of one plant were fully double to the tip of the columnar spike. The character was confined to a small colony.

The plants were quite well in flower when the place was visited, but as no seed was ripe, arrangements were made with Mr. William Sinclair to send me seed later in the season. He sent a liberal quantity from the best plants which had completely double flowers. Unfortunately, this seed germinated very poorly.

Propagation of this seed was for a time carried on at two places. At Arlington Farm, Va., one lot of the seed was sown and about one hundred plants were potted off and grown to maturity. To our chagrin only one plant showed the double character pronouncedly enough to suit us.

At Chico, Calif., three successive generations of seedlings were grown in all, each from double plants in turn, with similar results. Never over four or five per cent of doubling was secured and no more than one or two plants that were considered fit to have. Finally at Chico the stock was allowed to volunteer for three or four years in a waste place, when there appeared several very good individuals which have recently been propagated. One of these is a comparatively large, vigorous plant with deep maroon colored rays extending to the apex of the flower spike. The other is a more dwarf spreading plant having yellow rays with the doubling extending nearly to the top of the spike.

It seemed useless, since so small a percentage of plants came true, to attempt to get the character fixed in the seed. Indeed, the double plants seed very poorly anyway, and no gain seemed to be made in growing successive generations from seed.

The plants grow large and bushy in California, and an attempt was consequently made to propagate by layering. Earth was banked around the plants in autumn, but no rooting took place. After considerable effort, Mr. Henry Klopfer has succeeded very satisfactorily in propagating from cuttings.

The cuttings are made of terminal growth late in the season, just before frost, when the wood is fairly well ripened. A heel is obtained when possible, but this is not imperative if the cut is made just below a leaf. These cuttings are set in sand in the bench with a little bottom heat. Plenty of water with perfect drainage is necessary. The cuttings are discouraging at first, for it is difficult to keep them from wilting, but after a day or two they begin to take up water and stiffen up. They are handled much like geranium cuttings.

After about six weeks in sand, callousing has taken place and root action started. In six or eight weeks the cuttings are ready to be transferred to pots. This should be done very soon after root action starts for the roots are very brittle and there are only one or two of them going directly downward. If potting is long delayed there is considerable loss owing to these characteristics. Commonly, about eighty per cent of the cuttings are successful, but this result probably can be improved upon with experience.

For best results it is necessary to produce young, vigorous plants each year. Stocks carried over or those stunted and starved are not satisfactory. In one instance plants with perfectly doubled flowers had the doubling reduced fully one-half the second year when carried over winter in a poorly tended and watered herbaceous border. On the other hand, plants of the same progeny maintained the character when allowed to run untended in fertile waste places even in competition with the common weedy annual grasses.

DELAYED GERMINATION AND THE ORIGIN OF FALSE WILD OATS

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IN a recent issue of the JOURNAL OF HEREDITY one of the writers presented evidence concerning the origin of false wild oats, which indicates that they owe their origin to mutations rather than to natural crossing. Nilsson-Ehle[5]†, who was first to postulate mutations as the cause of false wild oats, has published[6] more evidence in favor of his theory.

Atwood[1] pointed out that delayed germination occurs in *Avena fatua*. He maintained that the restriction of oxygen by the seed coats was a limiting factor in germination and found that searing the seed coats with a hot needle materially increased the percentage of germination. Inasmuch as delayed germination exists in *A. fatua* one would naturally expect to find it also in false wild oats, provided false wild oats owe their origin to natural crossing between *A. fatua* and *A. sativa*. In the present paper are reported data obtained in an experiment made to determine the relative degree of delayed germination in false wild oats and in the second hybrid generation of certain crosses between *A. sativa* and *A. fatua*.

Methods

The plants used in this experiment were grown in the plant-breeding nursery on the Agronomy farm during the summer of 1922, from seed planted on April 3. At harvest time, which occurred between July 14 and July 21, the panicles of each plant were placed in a separate envelope and allowed to dry thoroughly in the sunshine before being stored in the laboratory. On September 15, kernels of all the plants reported on were placed in a standard germinating chamber. At the end of six days the germinated kernels were counted and removed. The remaining kernels were again placed in the chamber where they were left until September 28, when the final count was made. Before returning the kernels to the germinator some of them were treated either by searing the seed coats with a red-hot needle or cutting through the seed coats with a razor.

The seed-sample of each plant except in sixty instances consisted of twenty-five lower seeds. None of the upper seeds of an oat spikelet was used in the germination test. Because of scarcity of seed, each of twenty-one samples contained from ten to fourteen seeds inclusive and each of thirty-nine samples contained from fifteen to twenty-four seeds inclusive. In this test rag dolls were used as recommended by Holbert and Hoffer[4] for use in the germination of corn. From eleven to twenty-three samples were placed in each rag doll.

During the germination test the temperature was controlled by means of a water jacket and an ice chamber. Temperature readings were made morning, noon, and evening. From September 15 to September 21, when the first germination-count was made, the temperature was maintained between 17°C. and 19°C. From September 21 to Septemper 28 when the second and final germination-count was made, the temperature was maintained between 16.5°C. and 19.5°C. with the excep-

*Approved by the Director of the West Virginia Experiment Station.
†For Numbered References, see *Literature Cited*, at end of article.

tion of one night when a temperature of 15°C. was recorded.

Comparative Germination of Parents and Hybrids

The data for the germination test of Victory, *A. sativa*, Garton 748, *A. sativa orientalis*, and two varieties of *A. fatua* as well as the second generation seed of certain crosses, are shown in Table I. One of the fatua forms had a brown hairy lemma and the other had a yellow glabrous lemma.

In a few cases, seeds which showed no signs of germination at the expiration of six days and at that time were not treated by searing or cutting through the seed coats, showed weak germination at the end of thirteen days (Table II). The data in Table I are made up from the number of untreated seeds per plant which showed germination during the thirteen-day period.

Each of the fourteen Victory plants and five Garton 748 plants germinated 95 per cent or above. The eleven plants of the Yellow wild oat ranged from 0 to 55 per cent germination, whereas the eight plants of the Brown Hairy wild oat ranged from 0 to 25 per cent germination. Although the number of plants involved is somewhat small, the data indicate that the brown hairy wild oat shows a somewhat greater degree of delayed germination than the glabrous yellow wild oat. Data previously collected corroborate the above statement.

The individual plants of each second generation progeny tested show a wide range in percentage of germination. The only apparent exception is the cross Yellow Wild oat × Victory in which the range of germination is from 66 to 100 per cent. The reciprocal cross, however, shows a range in germination of 16 to 100 per cent. In the generations of all the other crosses, namely, Brown Hairy wild oat × Victory and the reciprocal, Garton 748 × Brown Hairy wild oat, and Garton 748 × Yellow wild oat, the range in germination is from 31 or below to 100 per cent. The data in Table I, comprising tests of seed-samples from 437 second generation plants, show that delayed germination is an inherited character and that in general the range in percentage of germination in the second generation is from the fatua parent to the sativa parent. The second generation individuals show a distinct piling up at the upper limit of the frequency distribution. In other words, delayed germination behaves as a recessive character in these fatua-sativa crosses.

The Test for Delayed Germination

In order to determine whether delayed germination was the main cause of seeds failing to grow during the first six-day period of the test, the ungerminated seeds of each of a larger number of plants were divided into two approximately equal lots. Before returning the seeds to the germinator one lot was treated either by cutting through or searing the seed coats and the other lot was untreated. After the treated and untreated seed had been in the germination chamber for an additional seven-day period, the number of seeds which had germinated was determined. The results are tabulated in Table II.

It will be noted from Table II that the germination of the Brown Hairy wild oat was less affected by treatment of the seed coats than was the germination of the Yellow wild oat or the second generation hybrid plants. Both the seared and cut seed of the second generation plants germinated approximately forty-five per cent while only one per cent of the untreated seed germinated. The data presented in Table II show that the seed treatment appreciably increased the percentage of germination.

When the germination test was completed it was found that the untreated seeds exhibiting delayed germination were still firm whereas seeds which failed to grow for other reasons were soft and partially decayed.

Relation Between Fatua Types and Delayed Germination in the Second Generation

In order to determine whether the fatua type was closely associated in inheritance with delayed germination, the second generation plants were classified on the basis of seed articulation, as fatua-like, intermediate, or sativa-like forms. The segregation in the second generation clearly indicated that a single factor difference controlled the type of seed articulation. Of all the crosses (including all plants whose seeds were not tested for germination), there were 110 fatua-like, 254 intermediate, and 124 sativa-like plants with regard to seed articulation (P. = 0.458). A correlation coefficient indicated linkage between type of seed articulation and percentage of germination for the second generation progeny of each cross was prepared. The tables were arranged so that a significant positive correlation coefficient indicated linkage between the fatua type of seed articulation and delayed germination. These correlation coefficients are presented in Table III.

All the coefficients except one in Table III are significant, and they show that in the second generation individuals delayed germination was associated to some extent with the fatua type of seed articulation. The magnitude of the coefficients, however, also shows that close linkage between these two characters did not exist. The lowest correlation ($r = +0.159 \pm 0.086$), was obtained in the progeny of the cross Yellow wild oat × Victory, and the highest correlation ($r = +0.538 \pm 0.048$) was obtained in the F_2 progeny of the cross, Garton 748 × Yellow wild oat.

High percentages of germination were frequently obtained from second generation plants with fatua seed characters. This is shown by the data in Table IV. The frequency distributions with respect to the percentage of germination of the fatua-like seeds for all the second generation progenies are shown. Only plants which produced seed with fatua-like articulations on both the primary and secondary seeds are considered in this group. There is a distinct accumulation of individuals at the upper limit of the distributions. Considering all the crosses, approximately one-third of the fatua-like plants produced seed which germinated from 95 to 100 per cent.

Linkage is indicated by the number of significant correlations obtained between the fatua-like second generation segregates and delayed germination. On the other hand a considerable number of these second generation segregates showed no delayed germination. These facts which are brought out in Tables III and IV indicate that in the fatua-sativa crosses reported in this paper delayed germination was linked with the fatua-like seed articulation, but the linkage was not close.

Germination of False Wild Oats

The homozygous and heterozygous false wild oats as well as the sativa forms reported below came from the same stock as those previously reported (Garber, 1922).[3] The progenies of heterozygous false wild oats showed segregation similar to that obtained previously. The segregation from heterozygous plants obtained in this investigation was as follows:

46 Victory, 74 heterozygous false Victory, 54 homozygous false Victory; 28 Garton 784, 84 heterozygous false Garton 784, 34 homozygous false Garton 784; 257 Aurora and heterozygous false Aurora, 76 homozygous false Aurora.

The phenotypes of Aurora and heterozygous false Aurora were so similar that no attempt was made to place them in a separate group. In general heterozygous false Aurora possessed a degree of awn development somewhat greater than that of pure Aurora but the difference was not marked.

The data in Table V show that there was no striking difference in seed germination among the various forms

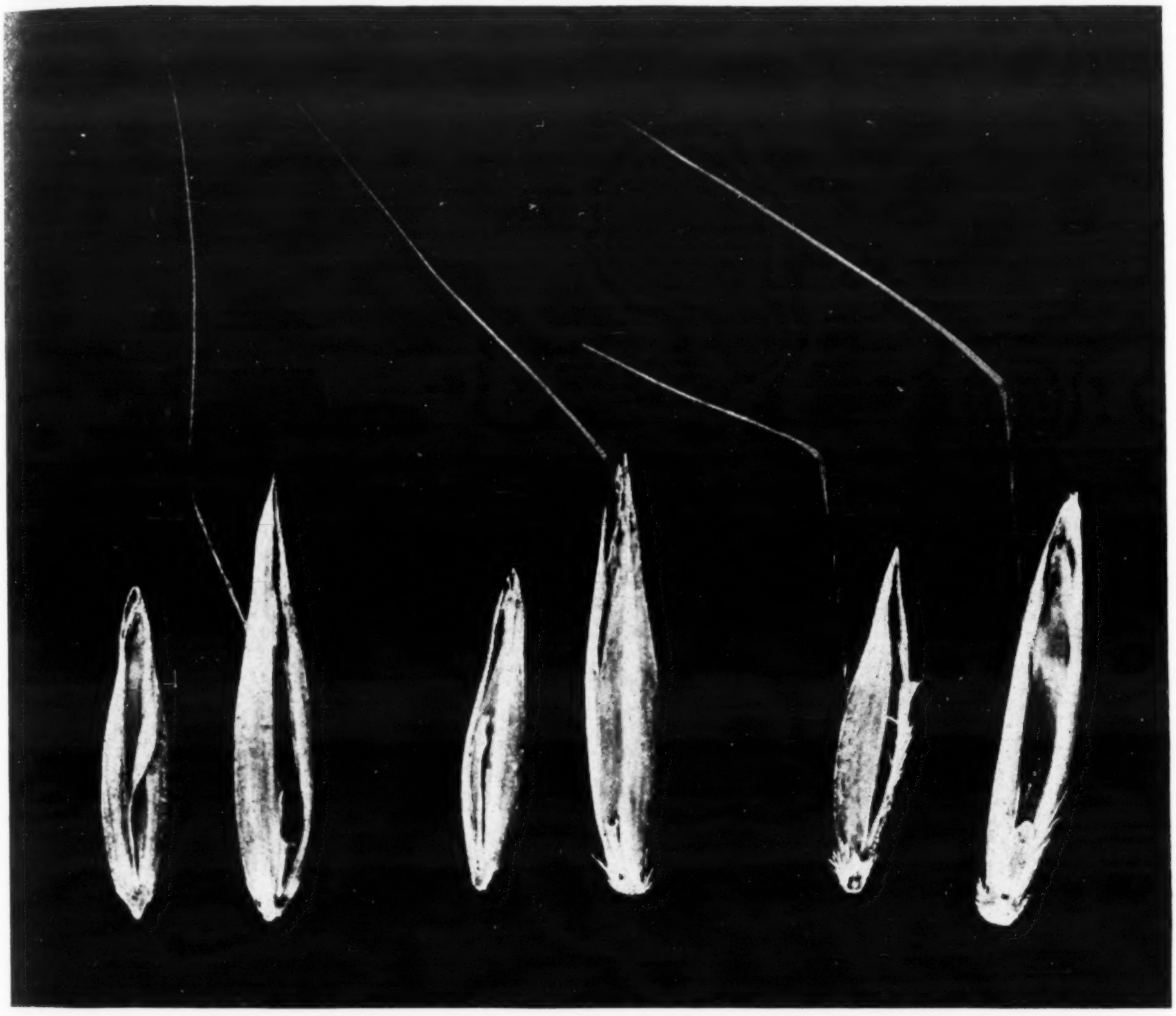
FALSE WILD OATS IN GARTON VARIETY

FIGURE 10. Left to right are shown normal, intermediate, and false wild Garton 784. The intermediate and false wild oats are characterized by awns, which are absent in the normal form. The false wild oats closely resemble wild oats (*Avena nuda*), and some authorities are of the opinion that false wild oats are due to natural crossing between wild and cultivated oats.

tested. In no case did a plant produce seed which germinated less than 70 per cent and only nine plants out of 184 produced seed that germinated less than 85 per cent. The sativa, the heterozygous false wild, and the homozygous false wild forms of the varieties Victory and Garton 784 are very similar with respect to seed germination. Homozygous false wild Aurora gave percentages of germination apparently somewhat higher than Aurora and heterozygous false wild Aurora.

The failure of some of the seed to germinate in the above forms was not owing to delayed germination. The seeds which showed no signs of germination at the end of six days were handled in exactly the same way as the ungerminated seeds of the parents and hybrids mentioned in the preceding section. In no case did a seared or cut seed of a sativa, a heterozygous false wild or a homozygous false wild plant germinate. Moreover every seed which failed to germinate during the first six days of the test, became soft and partly decayed by the time the test was completed (thirteen days.)

A year earlier a similar germination test was made of seed from homozygous false wild, heterozygous false



FALSE WILD OATS IN VICTORY VARIETY

FIGURE 11. Left to right are shown kernels of cultivated Victory oats, of intermediate (heterozygous) false Victory and of false wild Victory. Cultivated and false wild oats breed true, while the intermediate form segregates again, in the next generation, into normal, intermediate and false wild oats, in the ratio 1:2:1. The false wild oats are very similar to the true wild oats (*Avena fatua*) but the seed of the latter is delayed in germination by reason of having a heavy seed coat which is supposed to prevent oxygen from reaching the germinating embryo. This character is observed also in experimental crosses of wild oats with cultivated oats, but false wild oats does not show delayed germination. It therefore seems probable that false wild oats owes its origin to mutation rather than to natural crossing.

wild, and sativa forms of the varieties Victory and Garton 784. No difference in percentage of germination and no evidence of delayed germination were found.

The results mentioned above are similar to those obtained by Criddle[2] and by Nilsson-Ehle[6]. The evidence presented by these two investigators and the data reported here make it reasonable to conclude that false wild oats do not possess delayed germination similar to that found in *A. fatua*.

Conclusion

Seeds of wild oats possess delayed germination. Evidence is presented in this paper that in crosses between *A. sativa* and *A. fatua* delayed germination is an inherited recessive character and that it is somewhat loosely linked with the fatua-type of seed articulation. A germination test of seed produced by 437 second generation plants was made.

One would naturally expect to find delayed germination in some of the

TABLE I—*Frequency distributions showing percentage of germination of seed-samples from individual plants of the parents and second generation progenies of certain oat crosses.*

	PERCENTAGE OF SEEDS GERMINATED FROM INDIVIDUAL PLANTS																				
Name	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Total Number of Plants
Victory																				14	14
Garton 748																				5	5
Y. wild oat	2	1					1	2	2	1	2										11
B. H. wild oat	1	3	2	1	1																8
Y. wild oat × Victory														1	2	2	1	8	7	38	59
Reciprocal				1		1	1		2	1			3	3	1	3	1	13	6	42	78
B. H. wild oat × Victory			2		2	1						3	1	1	1	2	2	6	6	37	64
Reciprocal				2				1				3	2	2	4	5	2	2	7	32	62
Garton 748 × B. H. wild oat							2	3	1	1		2	4	2	3	4	8	5	10	28	73
Garton 748 × Y. wild oat	1	2					1	2	2	2		6	3	2	3	8	5	8	13	43	101

false wild oats, provided false wild oats owe their origin to natural crossing between fatua and sativa forms. Delayed germination was not found in seed from homozygous false wild, heterozygous false wild, or sativa plants. Here is direct evidence against the hypothesis that natural crossing between fatua and sativa oats adequately explains the origin of false wild forms. In view of the foregoing considerations, the origin of false wild oats is more reasonably explained by mutations than by natural crossing.

Literature Cited

[1] Atwood, W. M. A Physiological Study of the Germination of *Avena Fatua*. In *Bot. Gaz.* 57:386-414. 1914.

[2] Criddle, N. Wild Oats and False Wild Oats. Dominion of Canada Department of Agriculture, Seed Branch. *Bul.* S-7, 11 pp. 1912.

[3] Garber, R. J. Origin of False Wild Oats. In *Jour. of Hered.* 13:40-48. 1922.

[4] Holbert, J. R. and Hoffer, G. N. Control of the Root, Stalk, and Ear Rot Diseases of Corn. U. S. Department of Agriculture, *Farmers' Bul.* 1176, 24 pp. 1920.

[5] Nilsson-Ehle, H. Ueber Falle spontanen Wegfallens eines Hemmungsfaktors beim Hafer. In *Zeitschr. fuer induk. Abstamm. u. Vereb.* 5:1-37. 1911.

[6] ———. Fortgesetzte Untersuchungen uber Fatuoidmutationen beim Hafer. In *Hereditas* 2:401-409. 1921.

Table II—*Effect of cutting through or scaring the seed coats on delayed germination in oats.*

Name	NUMBER OF SEEDS								
	Seared	Germinated	Percentage	Cut	Germinated	Percentage	Untreated	Germinated	Percentage
B. H. wild oat	9	3	33.3	37	7	18.9	48	1	2.1
Y. wild oat	37	26	70.3	25	14	56.0	56	1	1.8
Seed of F_2 plants	212	96	45.3	215	101	47.0	305	3	1.0

Table III—*Correlation coefficients showing relation between type of seed articulation and percentage of germination in the second generation of certain oat crosses.*

Name	No. of Plants	r
Y. wild oat × Victory	59	+0.159 ± 0.086
Reciprocal	78	+0.422 ± 0.062
B. H. wild oat × Victory	64	+0.295 ± 0.077
Reciprocal	62	+0.477 ± 0.066
Garton 748 × B. H. wild oat	73	+0.485 ± 0.060
Garton 748 × Y. wild oat	101	+0.538 ± 0.48

TABLE IV—*Frequency distributions showing percentage of germination of seed-samples from fatua-like second generation individual plants of certain oat crosses.*

	PERCENTAGE OF SEEDS GERMINATED FROM INDIVIDUAL PLANTS																				
Name	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Total Number of Plants
Y. wild oat × Victory															1		1	3	1	7	13
Reciprocal				1		1	1		1				2	2	1	1		5	1	7	23
B. H. wild oat × Victory			2		1							1			1		2	1		6	14
Reciprocal				2								3		1	1	2	2		1	2	14
Garton 748 × B. H. wild oat							1	3	1	1		1	2			1	1	1		3	15
Garton 748 × Y. wild oat	1	1					1	1				3	1	1	1			1		1	12
Grand Total	1	1	2	3	1	1	3	4	2	1		8	5	4	5	4	6	11	3	26	91

TABLE V—*Frequency distributions showing percentage of germination of seed from homozygous false and heterozygous false wild oats as well as the sativa forms.*

	PERCENTAGE OF SEEDS GERMINATED FROM INDIVIDUAL PLANTS						
Name	71-75	76-80	81-85	86-90	91-95	96-100	Total No. of Plants
Victory				1	5	18	24
Het. F. Victory				3	1	21	25
False Victory		1		2	4	18	25
Garton 784	1			3	2	12	18
Het. F. Garton 784				2	3	18	23
False Garton 784		1	1	1	3	16	22
Aurora and Het. F. Aurora		3	2	5	6	10	26
False Aurora				1	1	19	21

EUGENICS IN FRANCE

A Review

THE World War cost France about 3,000,000 citizens, counting the deficit in births as well as actual deaths. Indirect consequences such as the malnutrition of infants, and the spread of diseases in the civil population, will doubtless account for several hundred thousand more individuals lost to the nation, if not already, within the next decade or two.

It is natural enough, then, that eugenics should have an increased interest for the French. The movement has never been influential in France, for a number or more or less obscure reasons. The fact that French scientists had little to do with the origin of this science may in some measure explain the lack of interest which they have shown in eugenics; then, too, many French biologists have Lamarckian leanings which do not predispose toward a conventional point of view. Again, the respect for personal liberty and freedom of opinion and action in France is incompatible with some phases of eugenics, at least as popularly represented.

For these and other reasons, eugenics as such has not played an important part in the republic. There has been for some years an active propaganda for more births, since for a long time the annual births in France have exceeded the annual deaths only slightly, if at all. But this propaganda has been quantitative, and has paid little attention to that point of quality which is the crucial one in all eugenic measures. The nation was one of the last to organize a society of eugenics, and this organization has never been numerically strong.

A series of addresses delivered by members of this *Sociétè Francaise d'Eugènique* has now been published[1] in book form—the first book, so far as I can recall, published in France in the direct interest of eugenics. It gives an extensive and trustworthy picture of the state of that science among the French.

Of the nine papers included, seven will be new to most students. Of the remaining two, one is a reprint of the address delivered by L. Cuenot at the International Congress of Eugenics in New York a couple of years ago; the other is a translation of an address on practical eugenics by Leonard Darwin. The other seven vary in character; several are thorough-going and admirable statements; others are timid and hesitant approaches to a point of view that is, to most Americans, commonplace enough. Thus it is something of a surprise to hear the late Edmond Perrier, former president of the society, confess that "in a civilized country, no one can dream of suppressing individuals burdened by hereditary defects, nor of preventing them from reproduction;" while F. Houssay supposes that the program of the movement must be a "war on defects, not on defectives." No one who has grasped the import of modern developments in genetics can fail to perceive that the only way to eliminate many defects is precisely to eliminate the defectives; and that the way to eliminate the defectives is precisely to prevent their reproduction. If many French eugenists hold such viewpoints as those just quoted, the prospects for an effective campaign are slight.

It is true enough that to favor

[1] Eugenique et Selection, par E. Apert, L. Cuenot, le Major Darwin, F. Houssay, L. March, G. Papillaut, Ed. Perrier, Ch. Richet, G. Schreiber. Pp. 248, prix f. 15 net. Bibliotheque Generale des Sciences Sociales, Librairie Felix Alcan, Paris (108, Boul. St. Germain), 1922.

the reproduction of the germinally superior is more important than to prevent the reproduction of the inferior (although each effort has its proper place in eugenics); and such measures as have been officially adopted in France, by tending to increase the birth rate, will have a valuable eugenic effect in so far as they are selective. But a review of them will show that they leave much to be desired.

1. The law of July 13, 1913, grants a monthly bonus to each family having more than three children under thirteen years of age; the bonus applying to each child in excess of three, and continuing until the child reaches his thirteenth birthday. The state, department, and commune join in the financial provisions for this bonus, the amount of which is not stated.

2. The law of June 28, 1918, promises state assistance to departments which give bonuses for children; the amount contributed by the state varying directly with the number of families having more than four children, and inversely with the wealth of the department. The law has in view not only an allotment for the maintenance of children, but a sort of insurance fund which will provide either a capital for the children when they mature, or else an old age pension for their parents. But the terms of this law, according to L. March, are too onerous to permit the participation of the poorer departments.

3. More than seventy large industrial organizations have established associations of their employees, somewhat similar to the familiar mutual benefit association. The employees contribute regularly small amounts, which they can draw out as their families increase in size; and the funds are increased by contribution of the employer, proportional to the amount of his total payroll. The last provision assures that the employer will have no interest in giving a job to a single man in preference to a family man.

4. Civil service employees, and also those of many private enterprises, receive regular increases in pay proportionate to increases in their families.

5. Tax measures provide an increase of twenty-five per cent in the income tax of bachelors, and exemptions for the fathers of families.

6. Members of large families are granted special rates on the railways.

7. The law of July 31, 1920, makes severe provisions against abortion and the sale of contraceptives.

Without stopping to analyze any of these measures in detail, one can see at a glance that such real eugenic effect as they may have is for the most part indirect and, so to speak, accidental. On the whole, they obviously represent an attempt to secure quantity of population, without definite provision for quality.

Numerous other measures are proposed by the writers in this volume. G. Schreiber, secretary of the French eugenics society, urges the importance of a compulsory medical examination prior to marriage,—without any prohibitory or other restrictive measures attached to it. Dr. Apert pleads for an intensification of the campaign against infant mortality, tuberculosis, syphilis, and alcoholism,—although all four of these afflictions are, strictly speaking, eugenic to some degree, and their reduction should therefore be accompanied by some real eugenic measures to counterbalance. F. Houssay, in a most interesting communication, argues that much of the sterility of civilized peoples is due to auto-intoxication, following particularly on the excessive use of meat, alcohol, and condiments, and cites in detail an experiment of his own in which fowls fed on an exclusive diet of fresh meat showed progressive sterility until in the sixth generation the line became extinct. Indeed, every one of the papers in this volume is distinctly worth study, not only because of the information presented, but because they show eugenics in what, to Americans, is for the most part a novel aspect.

—Paul Popenoe.

THE LIMITATIONS AND PROMISES OF EUGENICS

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IN A letter to Wallace, as long ago as 1857, Darwin said: "You ask whether I shall discuss man. I think I shall avoid the subject as surrounded with prejudices; though I fully admit it is the highest and most interesting matter for the naturalist." We have made enormous progress along many lines in the sixty-five years since Darwin made this modest but significant statement, but as students, are we yet able to place ourselves outside the herd and approach the subject of the evolution of human beings and human society in the spirit, and with the method, of science? As Karl Pearson submits the question, "Can we place ourselves outside the community of which we form a part, and study the effects upon it of environment, of occupation, of nourishment and of breeding in the same judicial manner as the owner of a herd of shorthorns approaches the like problem?" This question cannot be answered lightly, "yes" or "no," according to the taste or sentiment or disposition of the individual or the time.

Complicating any effort at an answer, Pearson suggests that, "We are not in the position of the owners, but we are members of the herd ourselves—with all the feelings of our class, the prejudices of our education, or want of education, the strong emotions of our sex and the complex passions of our race." As yet perhaps only the men of medicine and of the judiciary and a rare psychologist, are able to approach the ideal of placing themselves apart, and repressing sternly the personal for the furtherance and effectiveness of their respective professions. I mean that they can do this and still be interested in, and even love their fellow men, in contradistinction to that cold-blooded, nerveless placing of one's self outside the crowd for base purposes, a feat which can often be accomplished by the lowest and meanest. Outside the noble professions mentioned, and even some of their members are at times under suspicion, it is doubtful if the accomplishment of placing one's self apart and outside the herd is more than rarely effectively attained. If, however, it can be agreed that there are even a few who can study human beings and human affairs as cases and largely without the deep prejudices already enumerated, then we have made a promising start and a practical ideal beckons us on.

The Problem

An impediment in the path of progress is the question of the goal toward which to drive. Fortunately, so far as can be seen, this need not cause delay in the eugenics movement in the near future. Nevertheless, it will necessarily have to be considered eventually. Is the ideal a race with perfect form and health, the population limited so that there will be abundance for all, each individual observing the Golden Rule; no strife, no wars, all living in harmony and agreement, each for all and all for each; and everybody living to extreme old age? What a monotonous, uninteresting situation! Who would want to live there and then?

Dr. Schiller observes that:

[1] Presidential address before the Kansas Academy of Science, February 16, 1923.

Eugenics and civilization are actually in the same boat, and that the theoretic difficulties of the former are identical with those of the latter. Both are rooted in the notion of the good, but neither of them knows what the good is, and both are vitally affected by the doubts and disputes that beset the good. If we cannot tell what the good is, we can neither know how to better the human race, nor decide whether civilization is or is not a good thing. And in either case, if we disagree about the good, we shall get divergent aims, quarrel about it, and shall probably have to fight it out; with the result, very likely, that both sides will miss the good they aimed at.

To know what is the good, especially in such a large matter as civilization, is a far more complex matter than it is ordinarily considered to be. In the oasis and city Bokhara the number of inhabitants is strictly limited by the amount of water brought down from the mountains by the Zarafshan River, while from the country there is a very small emigration of the surplus population. Social and religious customs demand that every woman bear all the children possible, and death is a conspicuous feature, especially among the young. The enormous population, as in all Oriental countries, lives exceedingly scantily. With eyes opened wide with wonder I was being shown around by a Russian gentleman and was making photographs of the people and remarks about their slow ways, violations of the rules of sanitation and health, their complacency, improvidence, leaving everything to Allah, and so forth. Then my philosophic guide said:

> You see these people doing all these things so differently from the strenuous ways of your U. S. A., and you say to them: 'Bokharans, why don't you wake up and take to the strenuous ways of my country? Why put off till tomorrow that which can be done today; you fools!' I, a Russian from Moscow, say to them (this was a few days before the beginning of the late war), 'Why don't you wake up and do as we Russians do,' and I say 'you fools!' Then these people, as they sit around sipping their tea, philosophising, awaiting death and Allah, look at us from their quiet eyes, as we 'rubber neck' among them, and they say, 'You westerners, you nervous, strenuous people, quiet your nerves. Why do today that which can be put off till tomorrow? You fools!' Now, professor, I ask you, who are the fools?

Another angle of the same problem is given by Popenoe and Johnson:

> At the First Race Betterment Congress at Battle Creek, one afternoon the discussion turned to the children of the slums, and their conditions were pictured in dark colors. A number of eugenists remarked that such children were in many cases handicapped by a poor heredity. Then the revered Jacob Riis strode upon the platform, filled with indignation, and said:
>
> "We have heard friends here talk about heredity. The word has rung in my ears until I am sick of it. Heredity! Heredity! there is just one heredity in all the world that is ours—we are the children of God, and there is nothing in the whole big world that we cannot do in His service with it."
>
> It is probably not beyond the truth to say that in this statement Jacob Riis voiced the opinion of a majority of the social workers of this country, and likewise a majority of the people who are faithfully and with much self-sacrifice supporting charities, uplift movements, reform legislation, and philanthropic attempts at social betterment in many directions. They suppose that they are at the same time making the race better by making the conditions better in which people live.[2]

This introduces the problem, and it seems to me, states it very succinctly. It is the problem of the interactions of the factors of nature and of nurture, or the heritage and the environment. When this used to be a subject for discussion in the good old country school debates, we usually treated it as though one or the other, nature, or nurture, comprised the whole economy of an individual. In such a debate we succeeded about as well as when we took sides on that other ancient question entitled "What would happen if an irresistible force should meet an immovable body?" The answer usually was, "the inevitable." Like the old codger who, after looking a giraffe over, concluded: "Well, there just ain't no such animal," so we might begin with the premise that there is no such

[2] Popenoe and Johnson, *Applied Eugenics*. The MacMillan Co., 1918.

thing as the heritage without environment or the environment without the heritage—no possibility of the consideration of nature without nurture, or, nurture without nature. The factors of each are inextricably involved with the other. It is a big step forward that all can agree on this point, as I believe we do, but even so, we have only arrived at the stage where discriminate consideration is possible.

Are Acquired Characters Inherited?

We are impelled thus to inquire whether changes in the environment, or nurture, will change the nature that has been inherited in such manner that the changes that may be accomplished can be transmitted to the offspring.

Among the biologists I am sure it is well known that this question of the inheritance of acquired characters, or the induced mutability of the germinal substance, is to the front and is probably as lively a subject of discussion today as it ever has been in the past. Let us examine this question as well as may be possible in the time at our disposal. No detailed presentation of the data is intended now; only references may be made to some of the more prominent experiments.

In the famous experiments of Brown-Sequard, epilepsy and other characters were induced in guinea pigs by severing the spinal cord, or sciatic nerves. These acquired characters apparently were inherited by the offspring, but I believe geneticists now recognize that this claim has been refuted several times. I know no investigator who now attributes, except historically, the slightest importance to them.

Tower's experiments with potato beetles were popularly widely hailed as giving convincing proof of the possibility of the permanent modification of the substance bearing the factors of the heritage by the impingment of the environment, but critical examination of his data leaves much to be desired. I believe it is the consensus of judgment, and without disparagement of his brilliant achievements, that an open mind should be maintained concerning the interpretations which ought to be given to his results.

Kammerer, an Austrian biologist, has published accounts of experiments on the inheritance of induced characters in certain amphibia. In the one case a frog, *Alytes obstetricans*, is found in nature to have departed from the usual habits of frogs to the extent that the eggs are laid and fertilized while the pair are on the land. Afterward, the male, on whose hind legs the fertilized eggs are retained, seeks water where hatching takes place and a very short tadpole stage is passed. Furthermore, in nature, the male of *Alytes* does not have pads, or swellings, on his thumbs which are common on the thumbs of other frogs that mate in the water where the pads are thought to be helpful in holding to the bodies of the females. Briefly stated, Kammerer maintains that he has, by forcing these frogs to mate in the water through a few generations, caused them and their offspring to retain the habit of mating in the water, even when restored to conditions favorable for mating on land, and that the tadpole stage has been greatly lengthened. But of probably greater significance, the male has developed the pads, or swellings, on the thumbs which enable him to hold the females better while mating in the water. All this is thought to be a restoration, and causing to be inherited, of characters which these frogs are supposed to have lost, presumably by use and disuse, in the same way as they have now been restored.

Kammerer claims also that he has induced heritable color changes in salamanders by maintaining them on differently colored soils.

Professor Bateson has assailed Kammerer's work on a number of points which are too extensive to be

recounted here. Suffice it to say that Bateson leaves one in a very critical state of mind regarding Kammerer's claims. On the other hand, McBride, the English zoologist, gives credence to Kammerer's published results, and claims that Bateson is too severe with him. Nevertheless, it is the privilege, and even the duty, of scientists to maintain an attitude of skepticism on crucial results. Pending a better understanding of all the features of Kammerer's experiments, and independent repetition of them, an open mind is all that may be rightfully demanded of anyone.

Another experiment now in progress in the United States bears on this problem. Guyer and Smith, of the University of Wisconsin, injected emulsified lenses of the eyes of rabbits into hens. Afterward they took the blood serum of the hens, presumably containing rabbit lens anti-bodies and injected it into the blood stream of pregnant rabbits. When the young of these rabbits were born a few of them were found to have various degrees of defective lenses, the lenses having been almost eliminated in some cases. These lens defects have been inherited through several generations, through the male as well as the female parent. It appears that the anti-lens substance acted not only upon the lenses of the developing rabbit fetuses, but also on the germ plasm; or it acted on the lenses which in turn produced something that acted on the germ plasm.

This experiment, conducted by biologists of such integrity and training has aroused great interest. While as in almost all things, there is room for criticism of some phases of the experiments, nevertheless great hope of real progress in this field has sprung up.

That nurture may often have tremendous influence on the nature that has been inherited is made manifest in many ways, as illustrated by the effects of nutrition, poisons, heat and light, abrasions, friction, exercise, and so forth. Most people assume without question that such effects are inherited. Thousands of volumes could be crowded with the anecdotal evidence supposed to exemplify such inheritance. There are also the efforts of the scientists, many more than those that I have recounted. Nevertheless none of these accounts, nor the experiments, leave us quite certain that any such effects recur from generation to generation without the recurrence of the affecting agency. What an anomaly that with the abundant opportunities for observation not one single alleged case of the inheritance of acquired characters, or the induced mutation of the bearers of the heritage, can as yet be accepted with complete conviction.

That is, if the materials and conditions recorded as used in the experiment were duplicated we have no assurance that similar results would be obtained by independent workers. Until such unquestioned duplication of results are obtained by others using the same, or similar methods, the brilliant experiments of Brown-Sequard, Tower, Kammerer, and Guyer and Smith can hardly be accorded a position of greater consequence than that of harbingers of promise, and stimulates to further effort.

An effort has been made to present the most striking results tending to show that the effects of the environment may be transmitted. The tentative conclusion reached, at least by the speaker, is that entirely satisfactory proof has not been forthcoming.

The Immutability of the Germ Plasm

Now let us examine some of the evidence which indicates how difficult it is to influence the germ plasm by impingement with the environment. One line includes ovarian transplantation, another, identical twinning, and the third, Mendelian heredity.

The physiologist, Heape, took the fertilized egg of the long-haired, white Angora rabbit before its implantation

TWIN LAMBS, BUT DIFFERENT IN COLOR

FIGURE 12. The sire of these lambs was a black hybrid produced by crossing a Karakul ram with a Cotswold ewe, similar to the mother of the lambs. This illustrates Mendelian segregation of characters, as the black and white color-factors have not blended, but have remained distinct. If mated with white animals all the offspring of the white lamb would be white, while half of the black lamb's offspring would be black and the other half white.

and placed it in the uterus of the short-haired, gray Belgian hare. The Belgian hare than gave birth to a typical long-haired, white Angora rabbit, without the slightest resemblance of the Belgian breed. The Belgian hare to whose uterus the egg had been transplanted had been only the foster mother, having influenced the fetus, even in these most intimate of relations, not at all.

Castle and Phillips performed, in this connection, a very significant experiment using guinea pigs. It may best be described in Castle's words:

> A female albino guinea pig just attaining sexual maturity was by an operation deprived of its ovaries, and instead of the removed ovaries there was introduced into her body the ovaries of a young black female guinea pig, not yet sexually mature, aged about three weeks. The grafted animal was now mated with a male albino guinea pig. From numerous experiments with albino guinea pigs it may be stated emphatically that normal Albinos mated together, without exception, produce only albino young, and the presumption is strong, therefore, that had this female not been operated on she would have done the same. She produced, however, by the albino male three litters of young, which together consisted of six individuals, all black. The first litter of young was produced about six months after the operation, the last about one year. The transplanted ovarian tissue must have remained in its new environment therefore from four to ten months before the eggs attained full growth and were discharged; ample time, it would seem, for the influence of a foreign body upon the inheritance to show itself were such influence possible.

Another similar experiment has been performed in poultry by Daven-

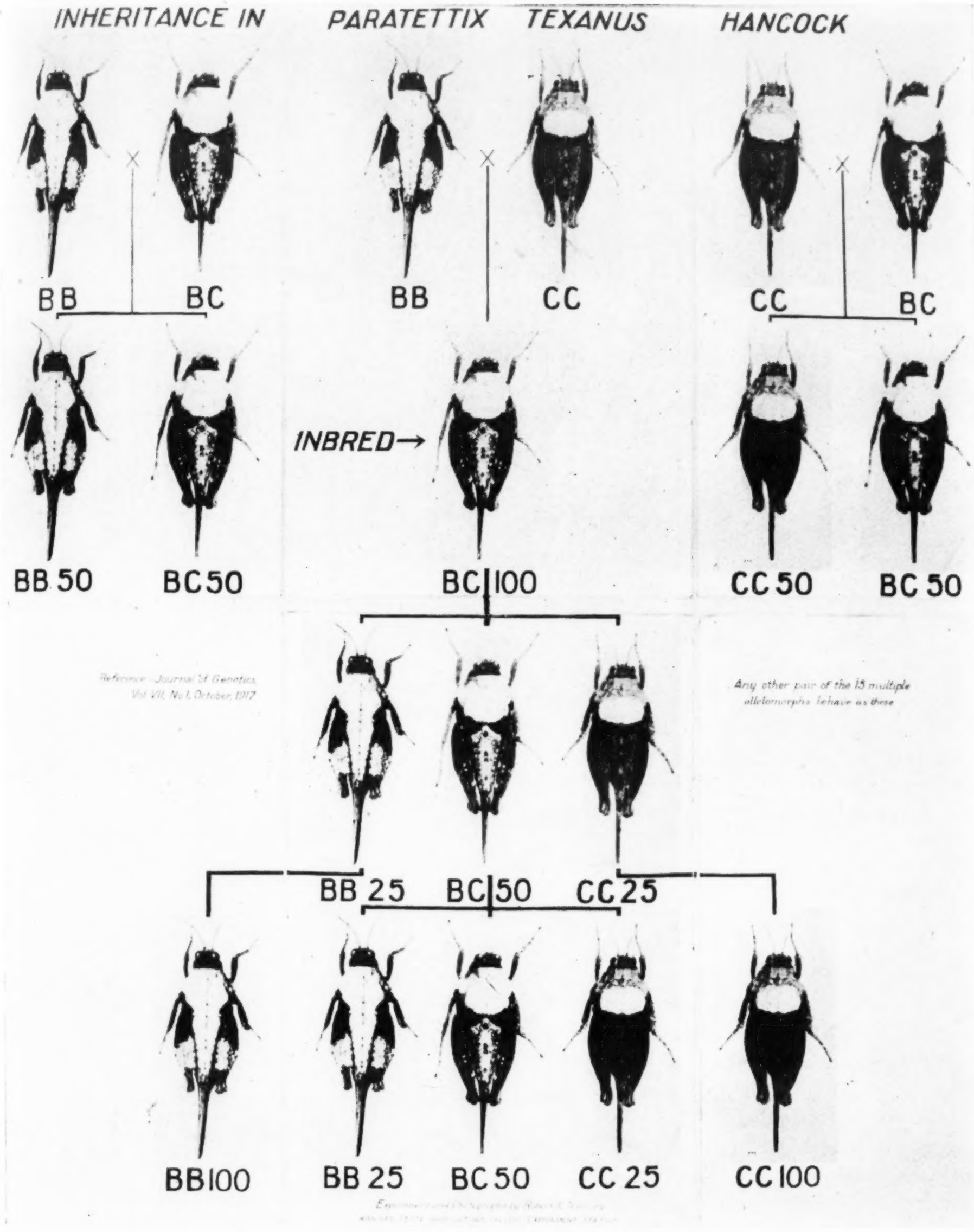
port and with results identical with those obtained by Castle, and Heape, with guinea pigs and rabbits, respectively. It is hardly necessary to suggest that these results offer striking evidence of the preponderant role played by the germ plasm in heredity. It appears that the germinal material is peculiarly insulated from the body as far as any influence on its capacity as the carrier of the heritage goes.

The causes of the appearance of the two kinds of twins in man appear now to be quite clearly understood, due to the brilliant work of Galton, Newman, and Patterson. The one class of twins may consist of a boy and a girl, or both may be of the same sex. In either case, the one usually differs from the other in respect to a few, or even a great many, characteristics, just as any brother may differ from brother, sister from sister, or as sisters from brothers. In this, the more common kind of twinning, it appears to have been quite definitely ascertained that each individual is derived from a separate egg, and as far as heredity is concerned, the difference between the two may be the same as if they were born years apart. Such twins as these I am sure you have often seen, this one tall and thin the other short and fat, the one with black, the other with blue eyes; the one with curly, the other with straight hair; the one with a certain disposition, the other entirely different, and so on, as might be the case among children born of the same parents at the usual intervals.

The other kind are designated as identical twins. They are invariably of the same sex, and are alike in practically all respects at birth. It appears well established that they are both derived from the same fertilized egg cell.

It was Sir Francis Galton, the father of eugenics, who made the first important study of identical twins, having collected accounts of eighty pairs. The records of thirty-five pairs were given with remarkably complete details. These records showed that such twins presented extraordinary resemblances in childhood, and these likenesses persisted to a remarkable degree throughout life. You are undoubtedly familiar with one or more pairs of such identical twins. They invariably have the same bodily characteristics, except in case of accident before, at, or after birth, and their mental and other traits appear also to be identical. If they suffer no deforming accidents, and are dressed in all respects alike, it is quite impossible to distinguish between them. It has been my fortune to become intimately acquainted with two pairs of such identical twins. In the one case two small elementary school girls were exactly alike, and dressed alike, and although I taught them every school day for several months, I never came to the point where it was possible to know them apart. Their resemblances extended to mental traits also. Two brothers were my college mates for four years, living in the same house, and part of the time in adjoining rooms. Although they were my intimate associates in many affairs, on account of their similarity, extending even to minute matters of habit, and as they took pride in dressing alike in all respects, I was never sure of their individual identity. One of them had spent some years with missionary parents in China, while the other had been with relatives in this country, and a good portion of their lives had been lived in different environments including food and climate.

Galton narrates numerous amusing as well as serious anecdotes concerning the eighty pairs of identical twins whose histories he studied. Most of these anecdotes related to the difficulties of parents, relatives and tutors and even of the twins themselves in distinguishing between the members of such pairs. In one case doubt remained whether the children were not changed in their bath, and the pre-



INHERITANCE IN THE GROUSE LOCUST

FIGURE 13. This photographic chart shows the inheritance of two allelomorphic characters in the Grouse Locust (*Paratettix texanus Hancock*). When the pure type BB is crossed with another pure type CC, the resulting locusts are all of the genetic constitution BC, with regard to the two characters in question. When these hybrids (the first hybrid generation, or F_1 of the geneticists) are inbred, three types are produced: pure BB's (25 per cent), BC's, similar to those in the preceding generation (50 per cent), and pure CC's (25 per cent). The two pure types breed true, while the hybrids (BC), when inbred give the same result as in the first generation. At the upper right and upper left corners are shown the results of mating a pure type with an intermediate. This chart could be used to illustrate the behavior of other characters in the Grouse Locust, and of many characters in plants and animals.

INHERITANCE OF COLORBLINDNESS—A SEX-LINKED CHARACTER

FIGURE 14. The factor for colorblindness is carried in the so-called X-chromosome, one of the two sex chromosomes. The small rectangles within the squares and circles represent the X-chromosomes, of which there are two in the cells of females and one in the cells of males. Colorblindness is recessive, and does not appear in the presence of its normal allelomorph. Therefore colorblind women are much rarer than colorblind men, as they only appear when a colorblind man marries a woman who carries the defect latently. Such a case occurred in the sixth generation shown in the chart, where the woman VI-15 is colorblind. The condition of her children with respect to this defect can be predicted with accuracy. None of her sons will ever distinguish red, green, or blue. They can never be railroad men nor belong to the signal corps. One-half of her daughters' sons will also be colorblind, although the daughters themselves will not be so afflicted—assuming, of course, that the colorblind woman marries a man with normal color vision. Chart prepared by Nellie Payne and the author.

sumed A was not really B and vice versa. Other incidents range from nine cases of a twin seeing his or her reflection in a looking-glass and addressing it in the belief that it was the other twin in person, to the difficulty which children found in distinguishing, in one case, a mother from her identical twin sister, and another case, a father from his identical twin brother.

In Galton's own words:

> Among my thirty-five detailed cases of close similarity, there are no less than seven in which both twins suffered from some special ailment or had some exceptional peculiarity. Both twins are apt to sicken at the same time in no less than nine out of the thirty-five cases. Either their illnesses, to which I refer, were non-contagious, or, if contagious, the twins caught them simultaneously; they did not catch them the one from the other.

Galton found that in many cases resemblances in body and mind continued unaltered up to old age, notwithstanding greatly altered conditions of life. He says further:

> The twins (not identical) who closely resembled each other in childhood and early youth, and were reared under not very dissimilar conditions, either grow unlike through the development of natural (that is, inherited) characteristics which had lain dormant at first, or else (if identical twins) they continue their lives keeping time like two watches, hardly to be thrown out of accord, except by some physical jar."

In the same careful, cautious manner, Galton examined the records of a large number of ordinary twins who were unlike from the start. It is a long catalog of increasing dissimilarities in many respects of body, mind, disposition, ability, immunities and susceptibilities, although the environment and training had been very much the same throughout.

He then concludes:

> There is no escape from the conclusion that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons of the same rank in society and in the same country.

So far practically all the discussion has centered on the question as to whether or not induced, or acquired, characteristics may be transmitted in the heritage. An effort has been made to present an unbiased summary of the evidence both for and against the idea. The only fair conclusion which seems possible is that the question may not at the present time be answered positively with yes or no. As indicated already, however, the alleged positive evidence is not satisfactory, while the facts against the idea are certainly quite strong.

Mendelian Heredity

The sentiment of Jacob Riis, and the word sentiment is here used advisedly, that by making the conditions better in which people live we are at the same time making the race better, certainly strikes the popular chord. If there were no alternative to this view that the heritage must be modified by the environment before race improvement is possible, the outlook, from the point of view maintained in this paper, would be gloomy indeed. Fortunately there are alternatives the features of which have undoubtedly been involved in race improvement for ages, perhaps without racial consciousness, or at least with only racial subconsciousness. These methods are still available, but whether for conscious application, or not, it would probably be imprudent at the present time to make predictions. One of these alternatives that I would like to place before you for examination consists of the principles and materials of Mendelian Heredity. Naturally only the barest outlines of so inclusive a subject may be presented, and I shall use, for the most part, some materials with which I am most familiar.

A breeding investigation using organisms such as the grouse locusts is justified and supported on the ground that this, supplemented by records of the breeding results in cattle, sheep, and pigs of other, including commer-

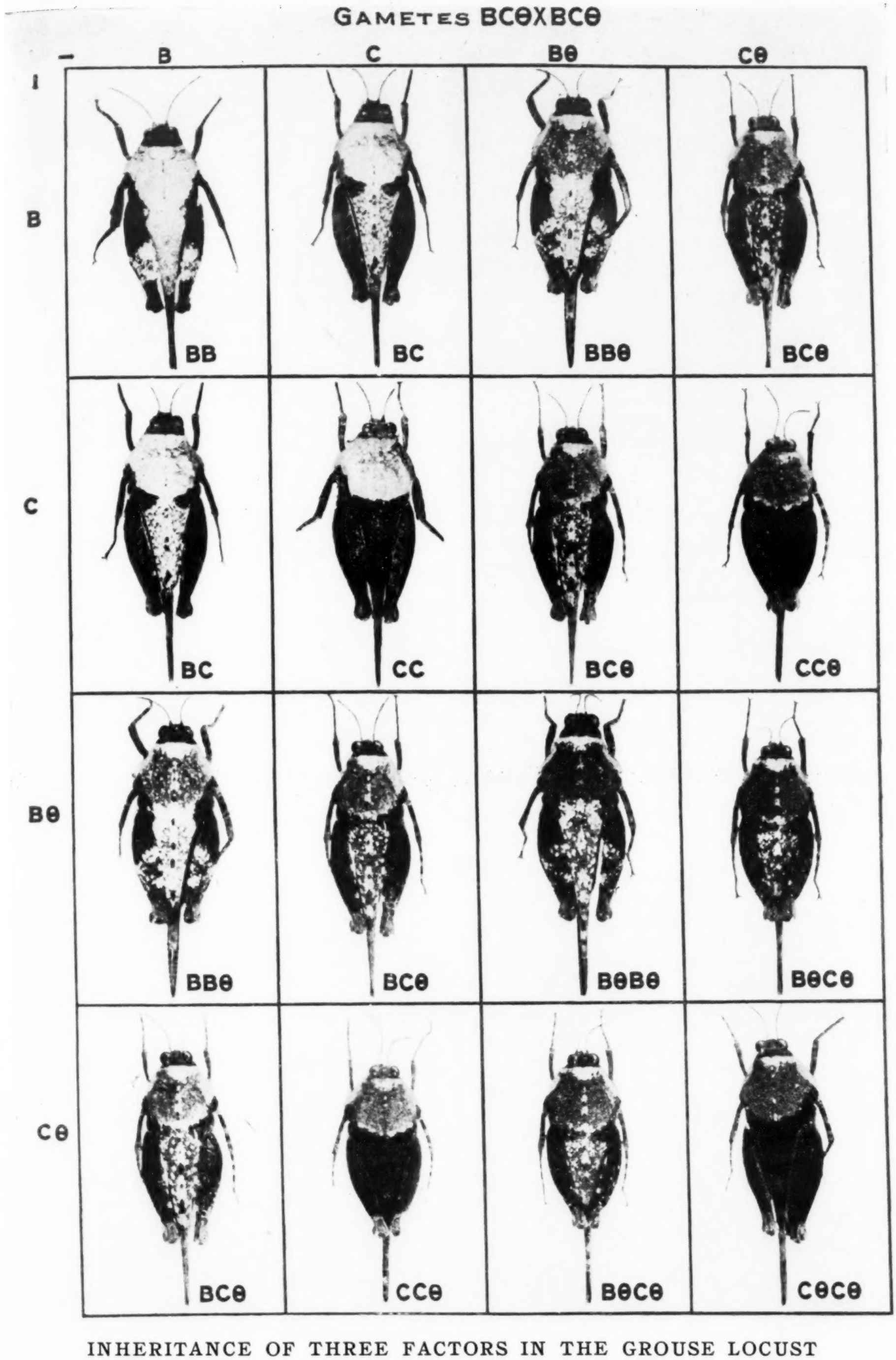
Woman marries a man with normal color vision. Chart prepared by Nelle Payne and the author.

cial, projects, and such records of human breeding as are available, would probably be the most direct method of approaching an understanding of the laws governing the inheritance of characters in domesticated animals and man. Thousands of grouse locusts of strikingly contrasting characters and for ten or twelve succeeding generations may be bred with the facilities, expense and time required in breeding one, or two, of the higher domesticated mammals. Just as the bulk of the facts of surgery and medicine has been gained largely through experimentation on lower animals, so it appears that an approach to an understanding of the laws of inheritance as applied to domesticated animals and man may be made, with proper supplementation, largely through the utilization in experimentation of such rapidly breeding and comparatively simple forms as fruit flies, grouse locusts and lower mammals.

Th breeding pens and cages of the geneticists are instruments analogous to the test tubes and mortars of the chemist. This is not overdrawn, for in the breeding of fruit flies millions of reactions of the factors of heredity have been recorded. In one experiment with grasshoppers we have checked and recorded more than 350,000 reactions among contrasting characters. Many other groups of animals and plants have been used in the same way. It is a fact that thousands of the factors which manifest themselves in the characters of animals and plants are every day being manipulated with the same precision and method as are applicable to the operations of the chemical elements. Even the same difficulties of errors resulting from contaminations, failure in the identification of end results, etc., have to be met. The precision with which genetic factors react towards each other has called for the establishment of a special branch or sub-branch of mathematics with which to deal with the subject; so that now when one contemplates entering the field of genetics he finds a knowledge of certain lines of mathematics a prerequisite.

There are about 140 characteristics of man known to be inherited. It has been ascertained that a large proportion of these are inherited according to Mendelian expectation, and none have been proved to be inherited otherwise. Color blindness, a chart for which I have shown (see Figure 14), is one of the conspicuous examples of those which have been thoroughly worked out. Skin color; the hair, whether straight, curly, kinkey, golden, red or black; tallness; dwarfness; thinness; fatness; bodily malformation; susceptibilities; immunities; inebrity; sobriety; sex immorality; criminality; inbecility; intellectuality; ambition; vigor; longevity; altruism and religious fervor are a few of the constantly increasing number of such heritable characters that are coming into recognition.

We have time to consider only one characteristic of man, besides the case of color-blindness already illustrated. I shall take the case of skin color of the negro studied especially by the Davenports. After extensive studies they concluded that there are two factors for black pigmentation in the full-blooded negro of the West coast of Africa. Briefly this means that the mulatto first generation offspring from pure black crossed with pure whites, when inbred, should produce one pure white and one pure black in every sixteen of the second generation offspring. (See Figure 15.) Now, this refers to color only. According to the laws of the shuffling of factors, the pure white individual in color may have more of the other negroid characteristics, such as flat nose, thick lips, curly hair, mental traits, than the pure black individual of the same parentage and *vice versa*. To secure a pure black, with all other negroid characters, or a pure white, with all other Caucasian traits from mulattos would be a very rare occurrence in-



INHERITANCE OF THREE FACTORS IN THE GROUSE LOCUST

FIGURE 15. The inheritance of color characters in the Grouse Locust is analogous to crosses between whites and negroes. White skin color in man is believed to be due to a single factor similar to that of the white Grouse Locust, BB (upper left-hand corner of chart). Black pigmentation of the negro is controlled by two factors, as is the case with the black Grouse Locust (lower right-hand corner). In crossing pure white individuals with pure black, hybrids or "mulattoes" are produced that have the genetic formula **BCθ** (the four figures running diagonally across from upper right to lower left.) When these "mulattoes" are inbred, the result is that represented by the sixteen figures in this chart. There are nine kinds of offspring, and all can be recognized. Of the sixteen, one will be pure white and one pure black, as far as color factors are concerned, but other factors are independently distributed.

deed. This accounts for the appearance, on South State Street, Chicago, for instance, of an individual as black as the ace of spades, but with a Caucasian face, straight (even red) hair, with the color, and possibly the mental makeup of a scion of the old South. On the other hand, one may see a lily white individual with negroid face, head, and hair, and many stages between these.

A criticism that comes to us frequently is to the effect that genetics, and especially eugenics, deals, for the most part with malformations and disorders of various sorts—"albinos, brachydactyls, cretins, dwarfs, freaks, giants, hermaphrodites, imbeciles, Jukes, Kallikaks, lunatics, morons, polydactyls, runts, simpletons, twins, and Zeros; in a very broad and general sense, pathological phenomena." The evolutionists particularly make much of this. Is the criticism justifiable? Morgan who has lately raised this point meets the challenge as follows:

> The genetist knows that opposed to each defect-producing element in the germ plasm there is a normal partner of that element which we call its allelomorph We cannot study the inheritance of one member of such a pair of genes without at the same time studying the other. Hence whatever we learn about those hereditary elements that stand for defects, we learn just as much about the normal partners of those elements. In a word, heredity is not confined to a study of the shuffling of those genes that produce abnormal forms, but is equally concerned with what is going on when normal genes are redistributed. This method of pitting one gene against the other furnishes the only kind of information relating to heredity about which we have precise knowledge.

To be sure there is no superman with with the time or capacity for controlling mankind as a herd, in order to make records of reactions of his characteristics in breeding. Yet, as pictured by Karl Pearson:

> Man himself makes the experiments which are directly impossible for the eugenist. This stock marries kin for six generations; those parents surfeit themselves with alcohol, there the tuberculous talent meets insanity; here the man of genius marries into his class; there he takes a woman of the people. There is hardly a phase of nurture and of environment, and of parentage and of ancestry which cannot be followed up, not in a single experiment, but in repeated experiments, if the time and energy to investigate are forthcoming.
>
> The science of eugenics does not propose to experiment on man; it endeavors to lay before us the experiments of man on himself, and this in such numerous cases that the evidence must carry with it conviction. Our object is to form an analytical record of man's experiments on himself, to draw from the history of his successes and failures the biological laws which govern his social development, and upon the basis of the knoweldge thus gained to predict what lines of conduct foster, what lines check national welfare.

A Guide Book To Health

WHY DIE SO YOUNG? by JOHN HUBER, A. M., M. D. Pp. 313. New York and London, Harper & Bros. 1921.

Dr. Huber's attempt is to outline a course of living for all periods, from infancy to old age, which will result in the best possible health. Logically enough, he begins his book with a discussion of heredity, and this might have been made both interesting and useful, for a great deal of material is available on the relation of health and disease to heredity. The author's discussion is superficial and inadequate, however. The rest of the book is made up of common sense advice written in an understandable way.

P. P.